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Preliminary Draft Environmental Impact Statement Volume 1

WyCoalGas Coal Gasification Project

Prepared for

U.S. Bureau of Land Management

August 1981

Woodward-Clyde Consultants
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60576C

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Mr. James Lambert
U.S. Bureau of Land Management
2515 Warren Avenue
Cheyenne, Wyoming 82001

Dear Mr. Lambert:

Enclosed for your review are the copies of the WyCoalGas PDEIS requested in your letter of July 15, 1981, as revised in a conversation with Mr. Courier on July 29, 1981. Also included is one copy each of the project description, meteorology, air quality, and noise, hydrology and water quality, and biology technical reports. Please note that since we did not receive some project description information until mid-July or later our analysis has not been completed. Some discrepancies between chapters may have also occurred in our attempt to incorporate as much information in the PDEIS as possible. However, we feel that the draft and the technical reports have addressed most of the major environmental issues associated with the project and that a critical review of the documents can be accomplished at this time.

As requested, PDEIS copies have been forwarded to the cooperating agencies. Each office identified in your July 15, 1981 letter also received one complete set of technical reports. It is understood that these agencies will provide you with comments on the PDEIS by September 1, 1981.

Sincerely,

Thomas O. Baily

Thomas O. Baily
Project Manager

cc with PDEIS Arvid Thomsen, Corps of Engineers, 6 copies
Art Anderson, Fish and Wildlife Service, 2 copies
Gary Wood, Fish and Wildlife Service, 2 copies
Susan Mamich, EPA, 5 copies
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Chapter 1

PURPOSE, NEED, AND DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

1.1 INTRODUCTION

WyCoalGas, Inc., a wholly-owned subsidiary of Panhandle Eastern Corporation (PEC), proposes to construct and operate a coal gasification project in southeastern Wyoming and northeastern Colorado. At full production, the project would produce approximately 300 million standard cubic feet per stream day (MMSCF/SD) of high-Btu synthetic pipeline gas (SPG) from about 10.2 million tons per year of Powder River basin subbituminous coal. Coal would be transported approximately 40 miles to the proposed gasification plant from a proposed surface mine dedicated to the project. WyCoalGas would construct and operate a private electric railroad to transport the coal and return ash from the plant to the mine for disposal. Gas produced at the plant would be transported approximately 160 miles via a proposed pipeline to an existing transmission system. The gas would ultimately be used by residential and industrial customers of Panhandle Eastern Pipe Line Company in Michigan, Illinois, Indiana, Ohio, and Missouri.

In order to construct several components of the project across public land in Wyoming, WyCoalGas is required to obtain right-of-way permits from the U.S. Bureau of Land Management (BLM) and U.S. Forest Service (FS). In addition, railroad and project-related pipeline crossings of certain rivers and streams must be permitted by the U.S. Department of the Army, Corps of Engineers under Section 404 of the Clean Water Act. Before decisions on applications for any of these permits can be made, the environmental impacts of the proposed project

Chapter I

PURPOSE, NEED, AND DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

1.1 INTRODUCTION

WyCoalGas, Inc., a wholly-owned subsidiary of Tenneco Eastern Corporation (TEC), proposes to construct and operate a coal gasification project in northeastern Wyoming and northeastern Colorado. At full production, the project would produce approximately 250 million standard cubic feet per stream day (MMSCF/SD) of high-Btu synthetic pipeline gas (SPG) from about 10.2 million tons per year of Powder River basin subbituminous coal. Coal would be transported approximately 60 miles to the proposed gasification plant from a proposed surface mine dedicated to the project. WyCoalGas would construct and operate a private electric railroad to transport the coal and return ash from the plant to the mine for disposal. Gas produced at the plant would be transported approximately 180 miles via a proposed pipeline to an existing transmission system. The gas would ultimately be used by residential and industrial customers of Tenneco Eastern Pipe Line Company in Michigan, Illinois, Indiana, Ohio, and Missouri.

In order to construct several components of the project across public land in Wyoming, WyCoalGas is required to obtain right-of-way permits from the U.S. Bureau of Land Management (BLM) and U.S. Forest Service (FS). In addition, railroad and project-related pipeline crossings of certain rivers and streams must be permitted by the U.S. Department of the Army, Corps of Engineers under Section 404 of the Clean Water Act. Before decisions on applications for any of these permits can be made, the environmental impacts of the proposed project

must be assessed. The BLM was assigned lead responsibility for the impact assessment, which is documented in this environmental impact statement (EIS).

In accordance with Council on Environmental Quality (CEQ) regulations, BLM involved the public in identifying significant issues and potential impacts of the proposed action that would be analyzed in the EIS. This was done through public scoping meetings held at Douglas, Gillette, and Cheyenne, Wyoming. The major issues identified were water, air quality, and socioeconomics. Therefore, the EIS places the most emphasis on the impact analyses for these areas. Analyses of impacts on vegetation, wildlife, aquatic biology, cultural resources, agriculture, recreation resources, visual resources, wilderness, geology, soils, and topography are also presented, although in less detail. The EIS assesses impacts from mining the coal for the gasification plant to the point that the gas is delivered to the existing transmission system.

This chapter includes background and organization of the WyCoalGas proposal; the purpose and need of the proposed project; a detailed description of the proposed action and alternatives, stressing impact-causing features; and interrelationships with other projects in the region. Information in this chapter has been summarized from the Project Description Technical Report (WCC 1981a), which is available from the BLM, Wyoming State Office, 2515 Warren Avenue, Cheyenne, Wyoming 82001, (307) 778-2220.

1.2 PROJECT BACKGROUND AND ORGANIZATION

Background

In response to increasing demand in its service area and decreasing domestic reserves of natural gas, PEC began exploring the possibilities of using alternative gas sources in the 1960s. In the

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1.2 PROJECT BACKGROUND AND ORGANIZATION

Background

In response to increasing demand in the service area and decreasing domestic reserves of natural gas, PGC began exploring the possibilities of using alternative gas sources in the 1980s. In the

early 1970s, WyCoalGas determined that coal, land, and water resources were available for a coal gasification plant in Wyoming. After conducting several studies of process and other unit design alternatives, a preliminary design for a gasification plant using Lurgi technology was developed in 1974. An environmental assessment of the project was prepared and submitted to a federal interagency review committee; however, because of the failure of federal loan guarantee legislation at that time, WyCoalGas requested that review of the assessment be terminated.

In 1976, WyCoalGas completed detailed gasification process engineering, and the conceptual design for the plant was refined. The project was again delayed pending loan guarantee legislation.

In 1980, Congress allocated funds to the U.S. Department of Energy (DOE) to be used to expedite development of synthetic fuels projects by private industry. The DOE dispersed these funds through cooperative agreements whereby projects considered likely to be completed were provided money for permitting and design to bring them to construction. If a funded project is constructed, the participating company must pay back the loan with interest. If the project is not constructed, the money provided under the cooperative agreement reverts to the form of a grant.

On April 25, 1980, WyCoalGas submitted a proposal for a cooperative agreement to the DOE. This proposal was selected for participation in the program and Cooperative Agreement No. DE-FC02-81RA50404 was consummated between WyCoalGas and the DOE. By accepting the agreement, WyCoalGas accelerated the proposed project beyond the pace that could prudently be pursued with internally granted funds.

Organization

As mentioned above, WyCoalGas would construct and operate the proposed gasification plant and electric railroad required for coal transportation. The company would also operate the water supply system for the plant.

Rochelle Coal Company, a joint venture of Pan Eastern Coal (a subsidiary of PEC) and Powder River Coal Company (a subsidiary of Peabody Coal Company) would be responsible for permitting and managing the proposed coal mine, called the Rochelle Mine. The mine would be operated by Peabody Coal Company.

The SPG produced at the plant would be purchased by Panhandle Eastern Pipe Line Company (PEPL), a wholly-owned subsidiary of PEC. The product pipeline required to transport the gas from the plant to the existing transmission system would be constructed and operated by PEPL.

1.3 PURPOSE AND NEED

Purpose

The purpose of the proposed project is to provide a long-range gas supply for Panhandle Eastern Pipe Line Company and its customers, while reducing the nation's dependence on foreign oil and gas and the threat of disruption from potential interruptions in those supplies. The proposed project would produce 300 billion Btu per day and could displace more than 16 million barrels of oil per year, representing an annual reduction of almost $575 million in payments for imported oil at current prices of approximately $36 per barrel. Of equal importance, the addition of SPG to the nation's overall supply of natural gas assures continued efficient use of existing interstate gas transmission and local distribution systems, adding many years of useful service to consumer appliances, heating systems, and industry.

Gasification

As mentioned above, Wydaliwa would construct and operate the proposed gasification plant and electric railroad required for coal transportation. The company would also operate the water supply system for the plant.

Bachelle Coal Company, a joint venture of Pan Eastern Coal (a subsidiary of PEC) and Porter River Coal Company (a subsidiary of Paxbody Coal Company) would be responsible for permitting and managing the proposed coal mine, called the Bachelle Mine. The mine would be operated by Paxbody Coal Company.

The SNG produced at the plant would be purchased by Paxbaxie Eastern Pipe Line Company (PEPL), a wholly-owned subsidiary of PEC. The product pipeline required to transport the gas from the plant to the existing transmission system would be constructed and operated by PEPL.

1.3 PURPOSE AND NEED

Purpose

The purpose of the proposed project is to provide a long-range gas supply for Paxbaxie Eastern Pipe Line Company and its customers, while reducing the nation's dependence on foreign oil and gas and the threat of disruption from potential interruptions in these supplies. The proposed project would produce 300 million bcu per day and would displace more than 15 million barrels of oil per year, representing an annual reduction of about $215 million in payments for imported oil at current prices of approximately $36 per barrel. Of equal importance, the addition of SNG to the nation's overall supply of natural gas assures continued efficient use of existing interstate gas transmission and local distribution systems, adding many years of useful service to consumer appliances, heating systems, and industry.

Panhandle Eastern's primary service area covers major portions of Michigan, Illinois, Indiana, Ohio, and Missouri. Approximately 25 percent of the total natural gas used in the contiguous United States is consumed in this area, and Panhandle provides approximately 23 percent of the area gas requirements (nearly one trillion cubic feet in 1979). Panhandle Eastern is the wholesale source of gas for 130 utilities and municipalities in the service area. These distributors supply approximately 2.7 million gas meters.

It has always been Panhandle Eastern's policy to maintain an aggressive acquisition program for domestic natural gas reserves. However, in the late 1960s, Panhandle was withdrawing gas from reserve to meet increasing market requirements by customers without being able to fully replace these supplies. For this reason, Panhandle began exploring alternative sources.

Panhandle Eastern investigated the feasibility of constructing a plant to gasify liquid hydrocarbons. Commercial technology is available for the production of SPG from naptha and other light hydrocarbons; however, this alternative did not appear to represent a wise use of a resource that is also in short supply.

Panhandle identified coal gasification as a viable alternative for supplementing supplies to their distribution system. The United States contains abundant economical reserves of coal, and coal gasification technology has been proven on a commercial scale in Europe and South Africa.

Panhandle Eastern has recently acquired, and is continuing to seek, domestic and foreign sources of natural gas. In 1974, Panhandle completed a gas-supply system from the Wattenberg Field near Denver,

Colorado. Beginning in 1970, the company has invested in gas exploration and production in the offshore Louisiana area. Participation in various partnerships has given Panhandle access to potential gas reserves from these offshore fields. Panhandle Eastern is actively pursuing the development of the proposed natural gas transmission system intended to transport Alaskan north slope gas via pipeline to the central United States. In 1973, the company concluded arrangements with Sonatrach, the state petroleum company of Algeria, to import as liquefied natural gas (LNG) the equivalent of 3.3 trillion cubic feet of gas. A terminal has recently been completed in Louisiana to receive this LNG.

In recent years, the effects of conservation by all classes of gas consumers, the advent of more efficient appliances and heating equipment, fuel switching by industrial users, and the depressed economy have reduced the overall demand for gas in Panhandle's service area. Concurrently, there has been an increase in the volumes of flowing gas available for transmission, primarily as a result of high production rates from newly developed gas fields.

The combined effect of these conditions has created a surplus of gas in Panhandle's system. However, this surplus is not expected to extend beyond the next few years because current production has not been completely replaced on a national basis. Between 1975 and 1979, only 56 percent of the volume of gas produced in the United States was replaced (Robert W. Reed, Panhandle Eastern Corporation, personal communication, 1981). These circumstances reinforce Panhandle's policy of aggressive acquisition of conventional gas reserves and necessitate development of supplementary sources, such as coal gasification.

In 1980, Panhandle Eastern forecast the residential, commercial,

and industrial demand for gas in its primary service area through 1995. Competitive fuel prices, conservation efforts, fuel-burning flexibility, and changing levels of economic activity were key elements of the analysis.

This study forecast demand for gas in the primary service area to increase gradually through the mid-1980s, due primarily to a temporary increase in gas availability and its competitive price position. However, in the late 1980s, total gas demand is expected to decline slightly as conservation offsets new load growth. Residential demand is expected to decline throughout most of the forecast period as a result of significant increases in residential conservation, although gas is projected to retain a relatively high market share. On the other hand, commercial demands for gas are expected to increase throughout the forecast period. In the industrial sector, the effects of higher oil prices and improved gas supplies are evident in the increased demand for gas at the beginning of the 1980s. Industrial gas demand after 1985 is expected to decline somewhat due to a reduction in the rate of growth in total energy demand for the industrial sector and some loss in market share for gas after deregulation.

While the demand for gas in Panhandle's service area will decline over the forecast period, supplies will decrease at a greater rate. Table 1.3-1 compares forecasted supplies of gas to Panhandle from all sources (i.e., domestic reserves, LNG, and the proposed coal gasification project) with demand through 1995. Shortfalls in gas supply are expected to begin by at least 1985 unless further sources are obtained. As indicated in Table 1.3-1, the proposed project would play an important role in decreasing Panhandle's project system deficiencies.

TABLE 1.3-1

SUPPLY/DEMAND FORECASTS FOR GAS IN THE PANHANDLE EASTERN SYSTEM (billion cubic feet)

Expected supply shortfall	Actual Consumption (1978)	Forecast 1985	1990	1995
Supplies from all sources except coal gasification	2,477	2,527	2,414	2,266
Coal gasification	0	0	102	102
Total Demand	2,477	2,707	2,679	2,634
Expected supply shortfall in service area	0	180	112	215

Source: Robert W. Reed, Panhandle Eastern Corporation, personal communication, 1981.

TABLE 1.3-1

SUPPLY/DEMAND FORECASTS FOR GAS IN THE
PANHANDLE EASTERN SYSTEM
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Expected supply shortfall	Actual Consumption (1978)	Forecast 1985	Forecast 1990	Forecast 1995
Supplies from all sources except coal gasification	2,477	2,527	2,414	2,546
Coal gasification	0	0	102	102
Total Demand	2,477	2,707	2,679	2,594
Expected supply shortfall in service area	0	180	112	215

Source: Robert W. Reed, Panhandle Eastern Corporation, personal communication, 1981.

Need

Under Title V of the Federal Land Policy and Management Act of 1976 (FLPMA) (43 USC 1971), the BLM is authorized to issue grants of right-of-way for industrial facilities that cross lands under its jurisdiction. WyCoalGas has submitted applications for right-of-way grants on 5.99 acres of public domain land that would be inundated by the reservoir included in the water supply system for the plant (Serial Number W47428) and 75.052 acres (8,173.120 feet at 400-foot-wide right-of-way) of public domain land to be crossed by the proposed electric railroad (Serial Number W64644).

In accordance with the National Environmental Policy Act of 1969, it is the responsibility of federal agencies to prepare an EIS for an action which may cause significant environmental impacts. The BLM has determined that issuance of the right-of-way grants for the proposed project would constitute a major federal action requiring an EIS.

1.4 PROPOSED ACTION

General Description

The proposed coal gasification project would consist of five major operating facilities: (1) coal gasification plant, (2) water supply system, (3) product pipeline, (4) electric railroad, and (5) surface coal mine. These facilities are shown conceptually in Figure 1.4-1. Figure 1.4-2 shows the location of the facilities. More detailed location maps are provided in Figures 1.4-3 through 1.4-12.

During project construction, approximately 11,250 acres would be disturbed (Table 1.4-1). Approximately 32 percent of this land is federally controlled. All of the land to be disturbed by the product pipeline and water supply pipelines (2,137 acres) would be reclaimed

Water

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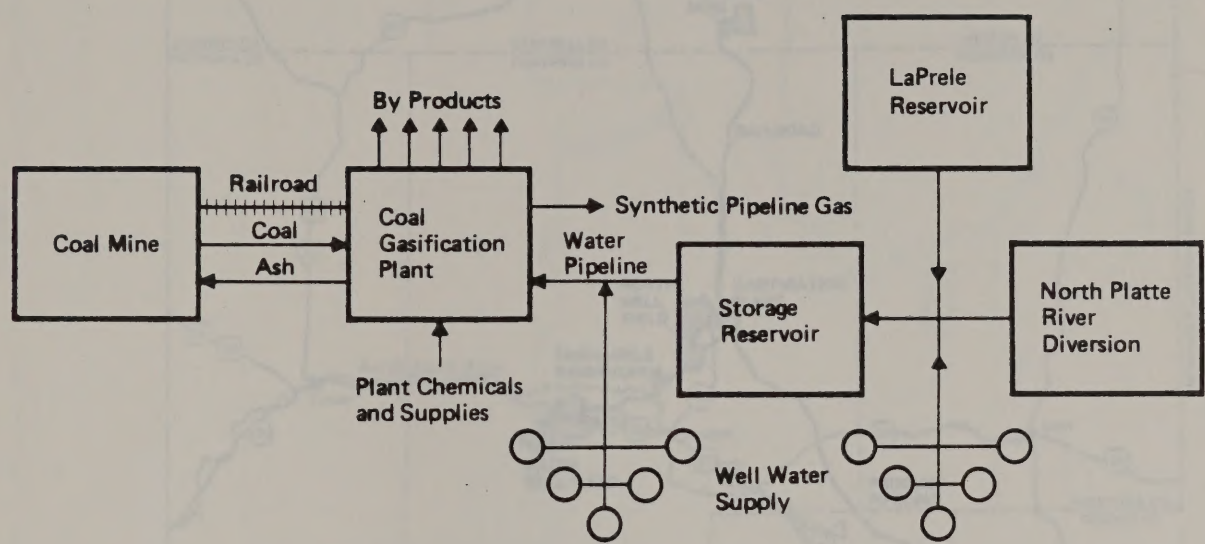


Figure 1.4-1
COAL GASIFICATION COMPLEX—PROPOSED MAJOR FACILITIES

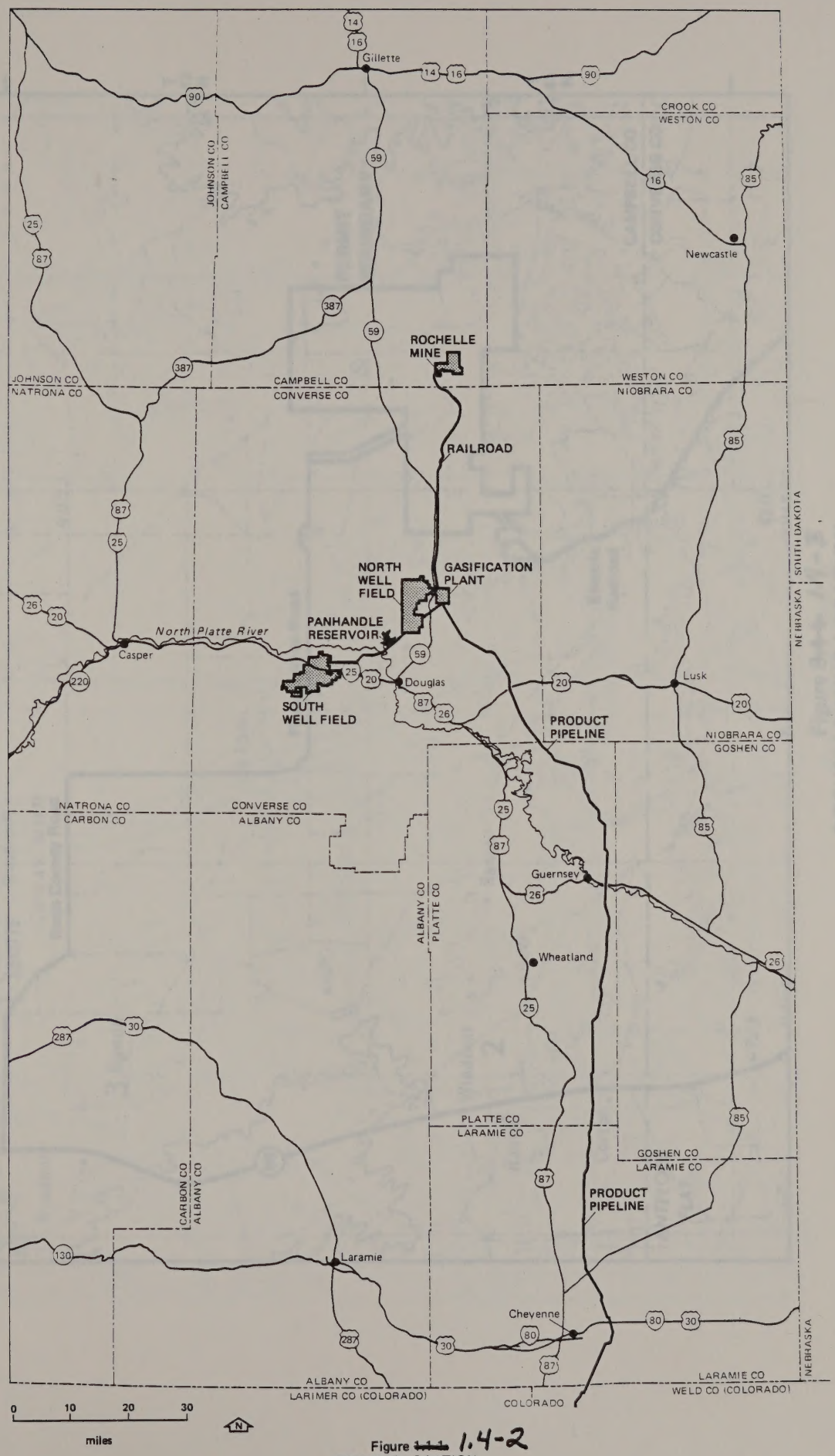


Figure ~~1.1.1~~ 1.4-2
PROJECT LOCATION

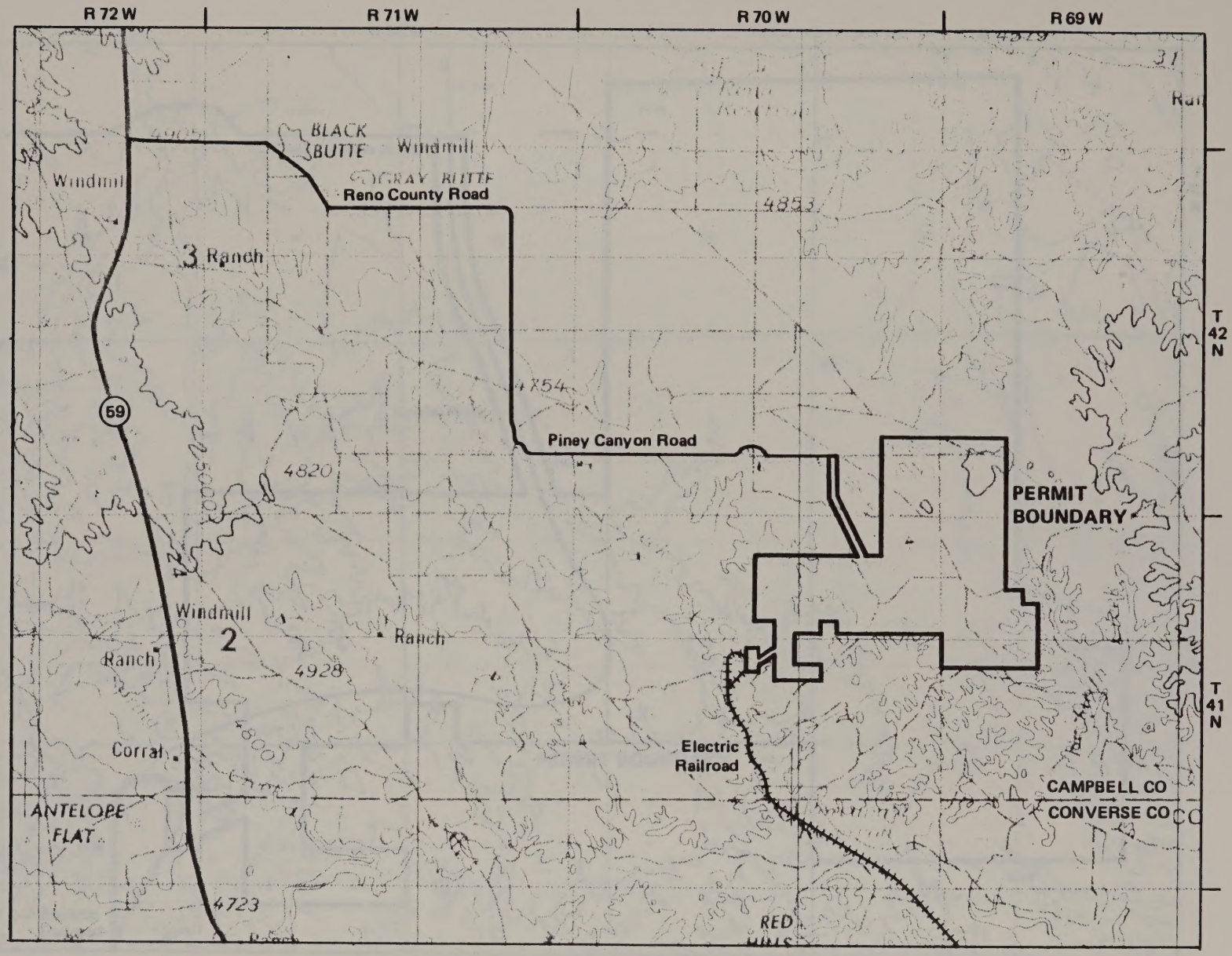


Figure ~~3.4-1~~ 1.4-3
ROCHELLE MINE LOCATION

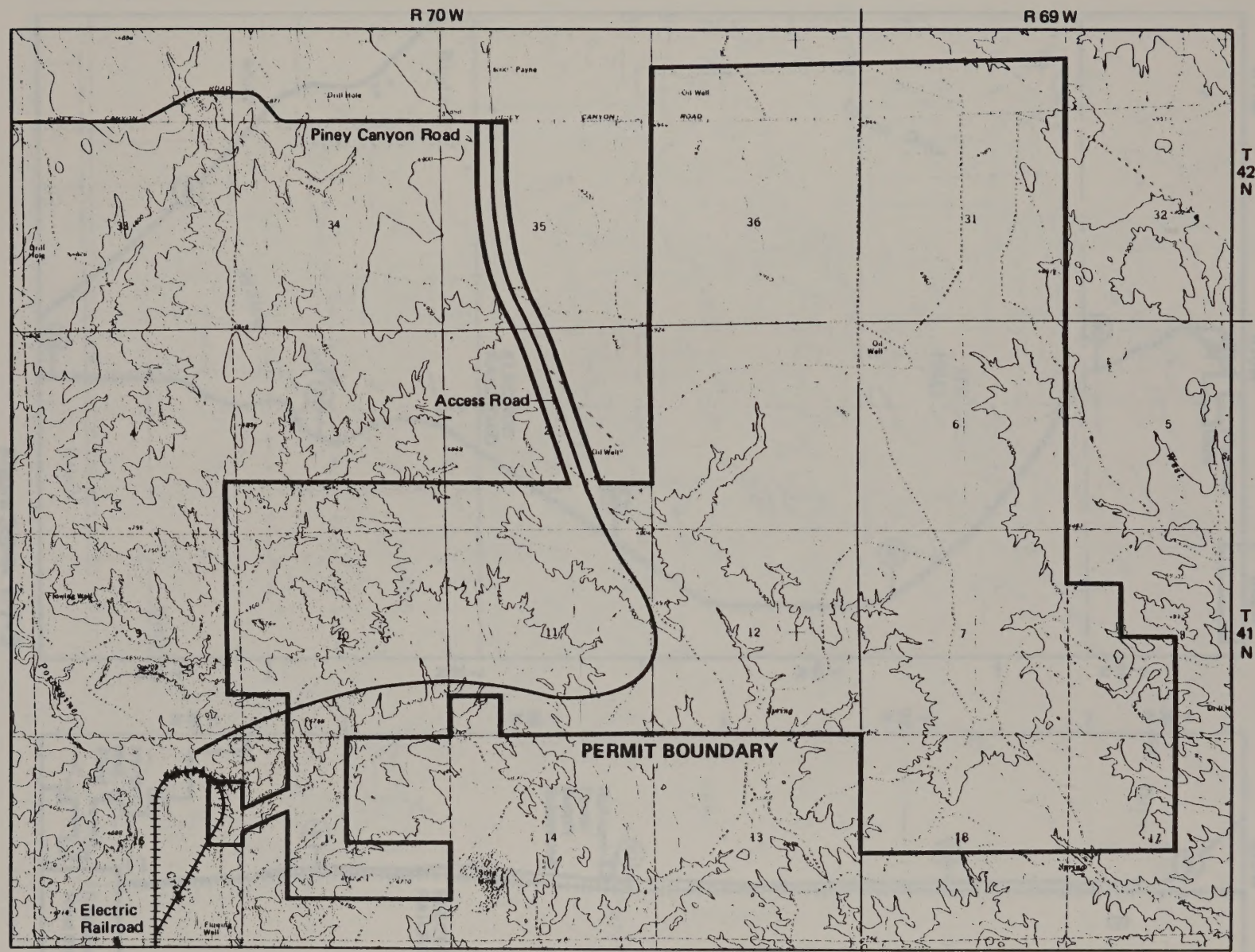


Figure ~~3.4-2~~ 1.4-4
ROCHELLE MINE PERMIT BOUNDARY

1-13

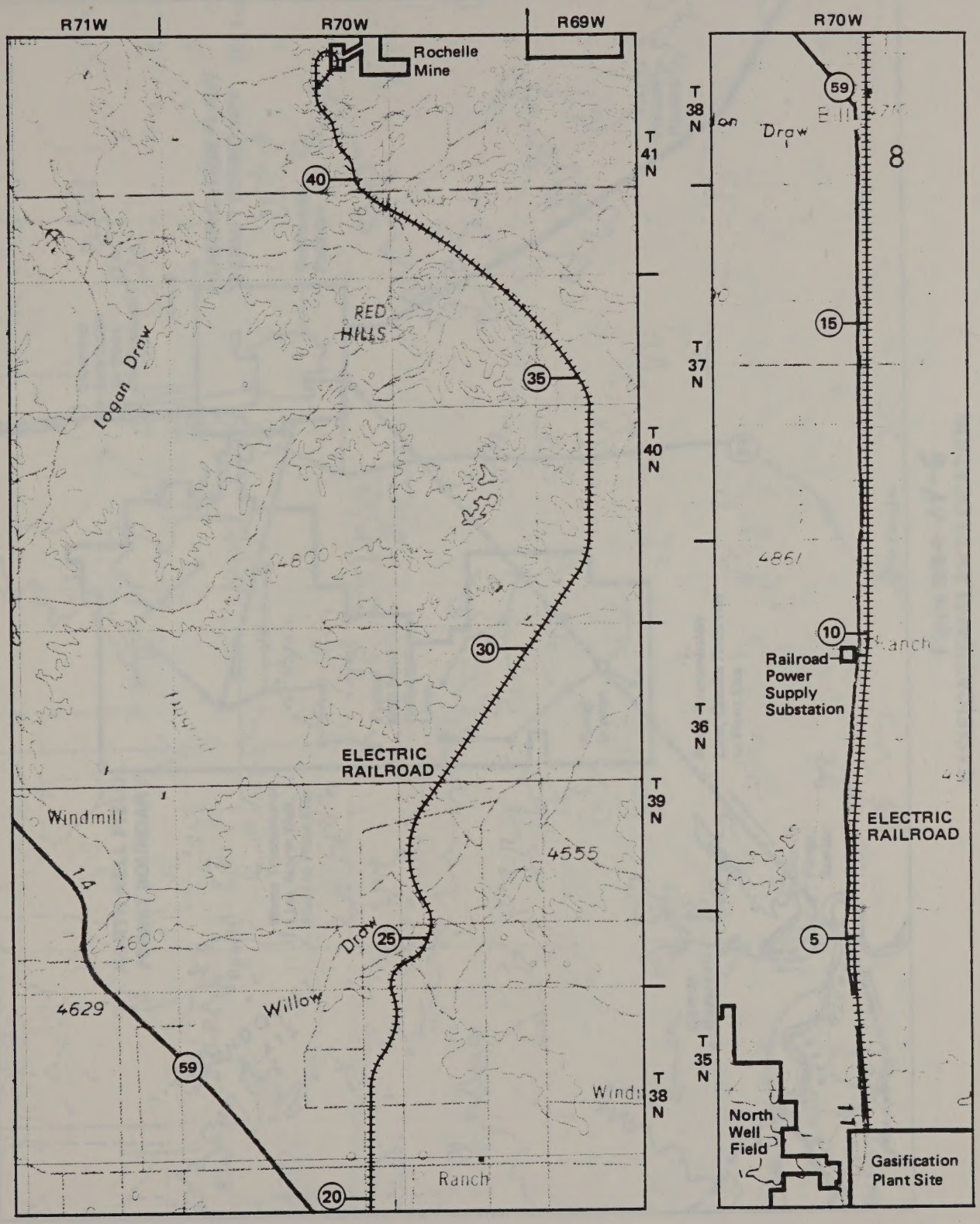


Figure ~~3.5-1~~ 1.4-5
COAL TRANSPORTATION RAILROAD

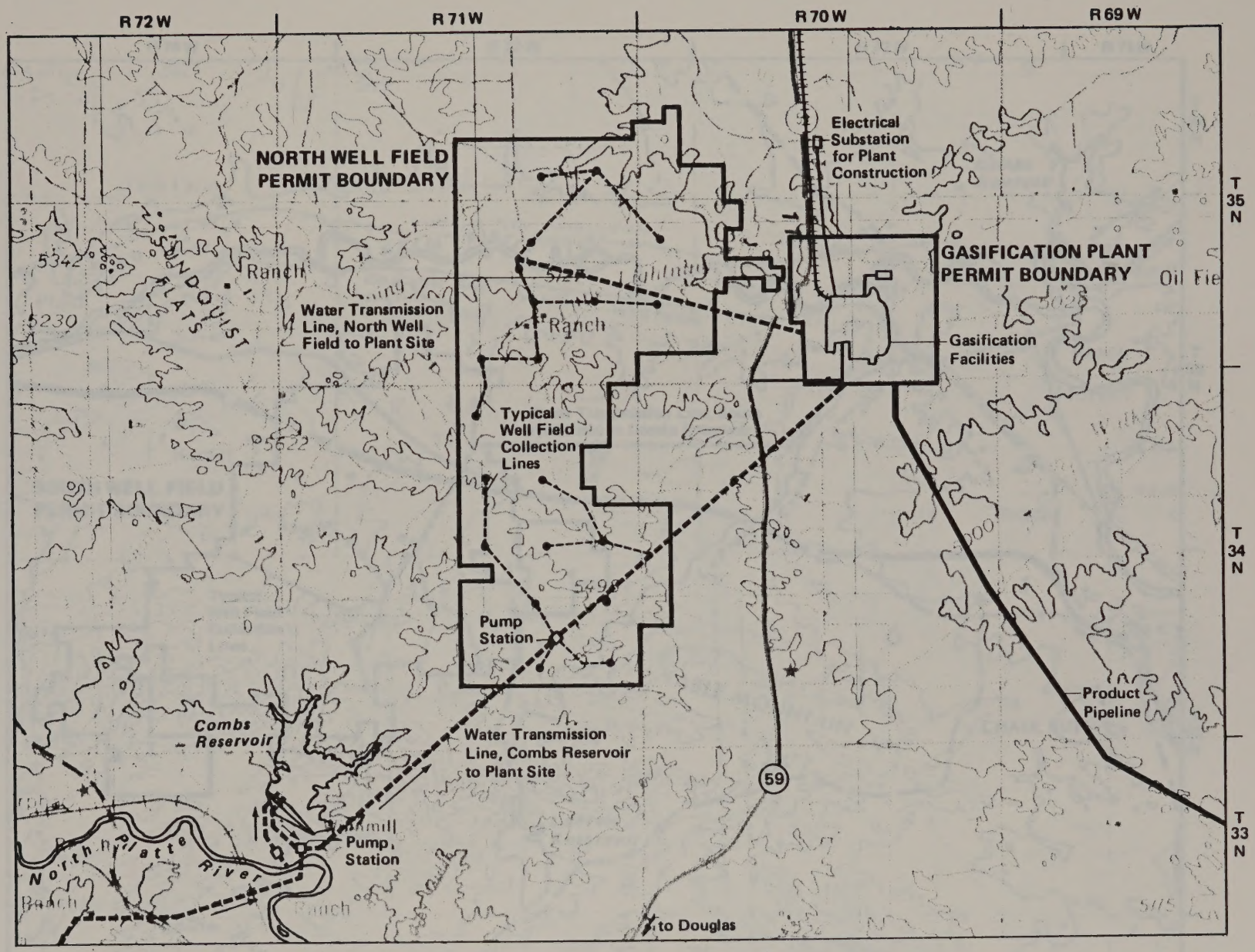


Figure ~~3.3-1~~ 1.4-6
GASIFICATION PLANT LOCATION

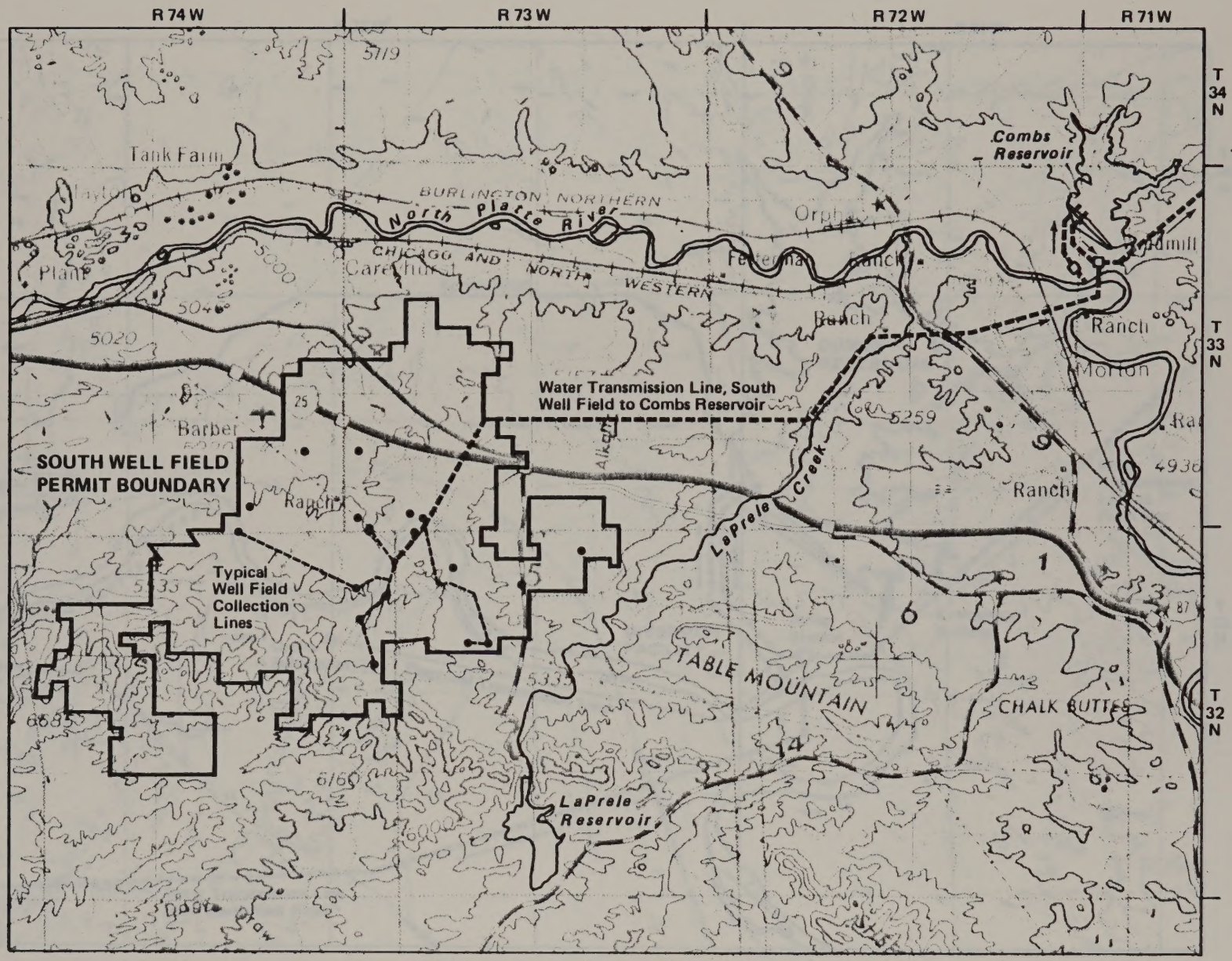


Figure ~~3.6-2~~ 1.4-7
SOUTH WELL FIELD, LAPRELE RESERVOIR, AND COMBS RESERVOIR LOCATION

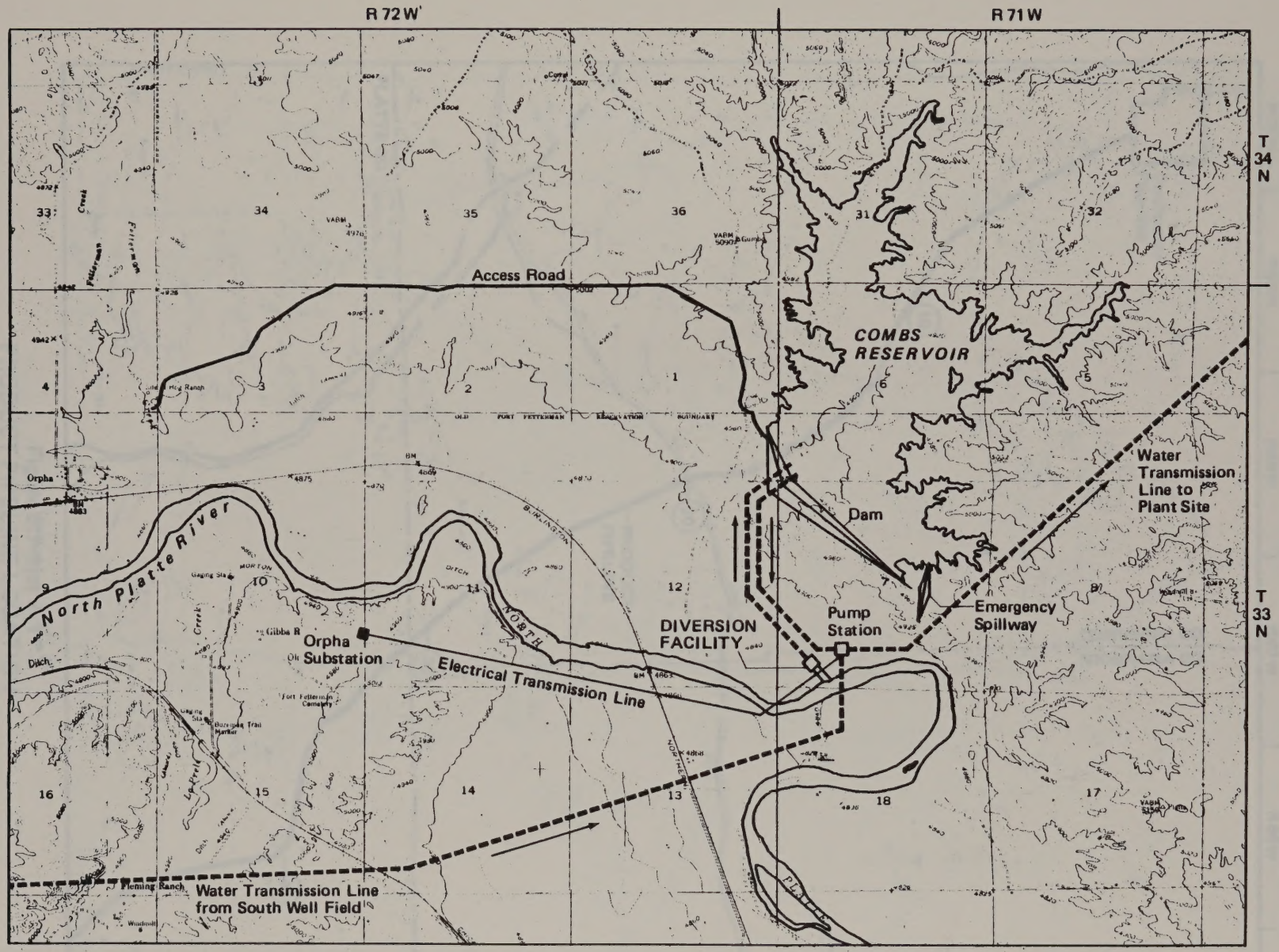


Figure ~~3.6-3~~ 1.4-8
COMBS RESERVOIR AND NORTH PLATTE DIVERSION FACILITY

L1-1.

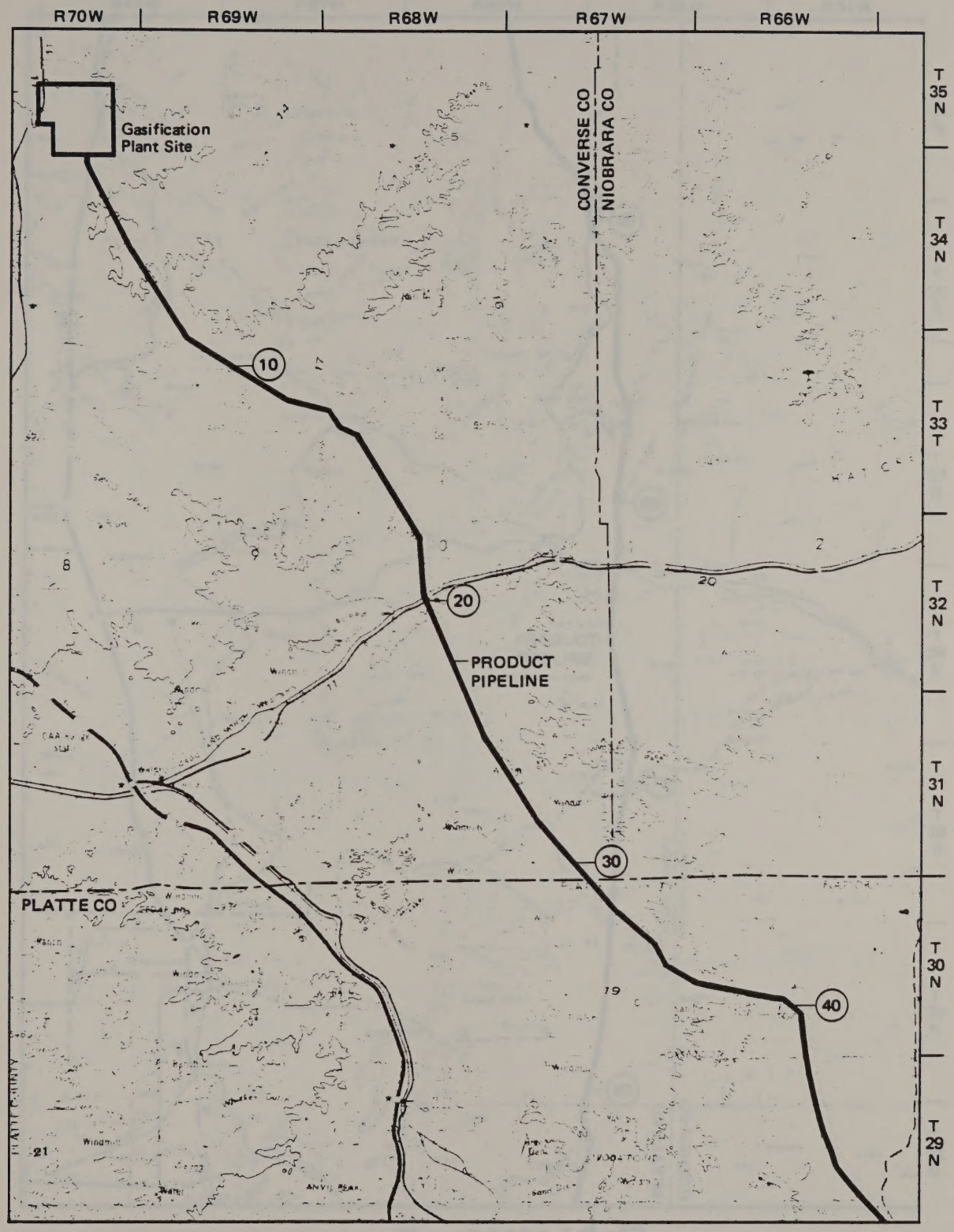


Figure ~~3.7-1(a)~~ 1.4-9
PRODUCT PIPELINE LOCATION

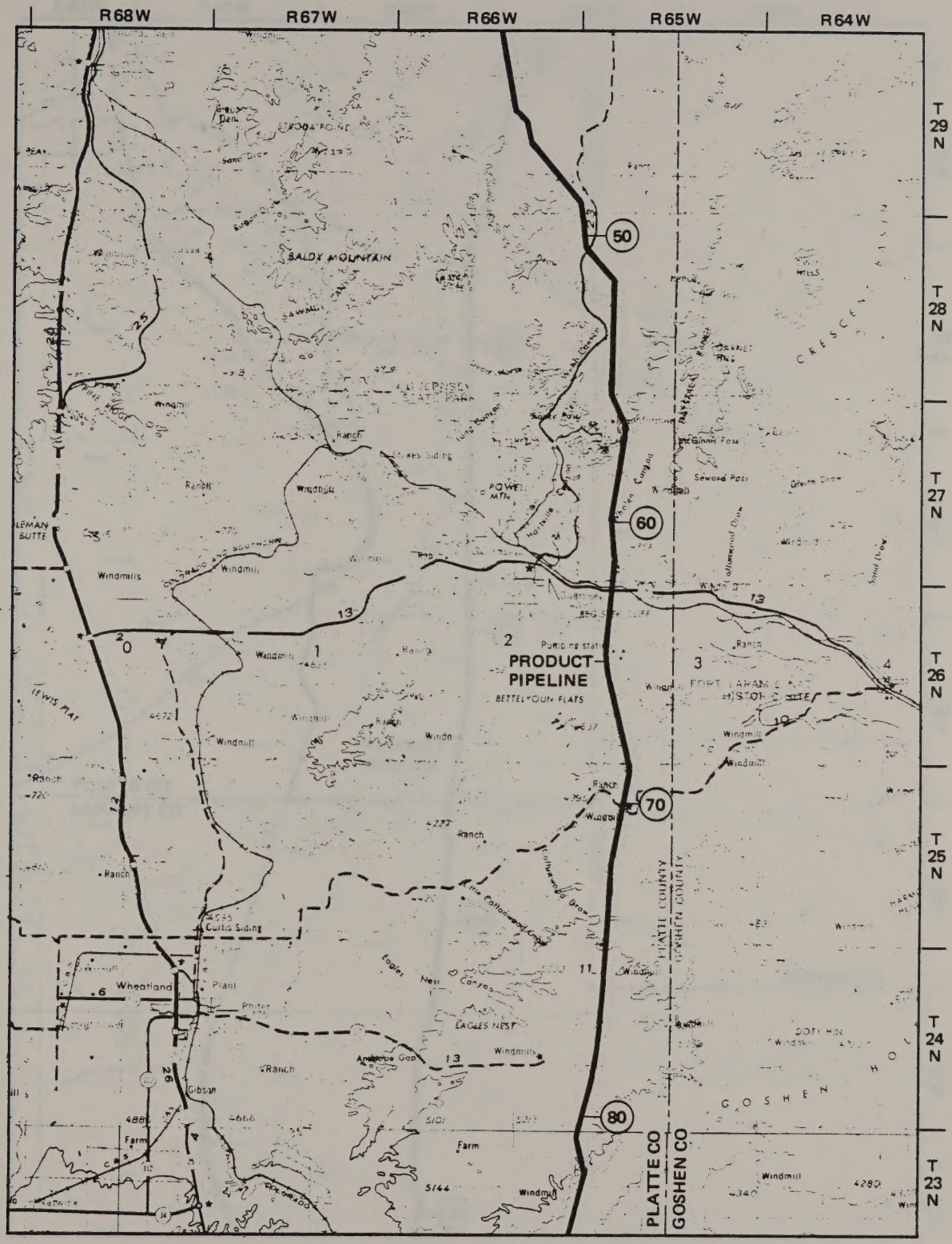


Figure ~~3.7-1(b)~~ 1.4-10
PRODUCT PIPELINE LOCATION

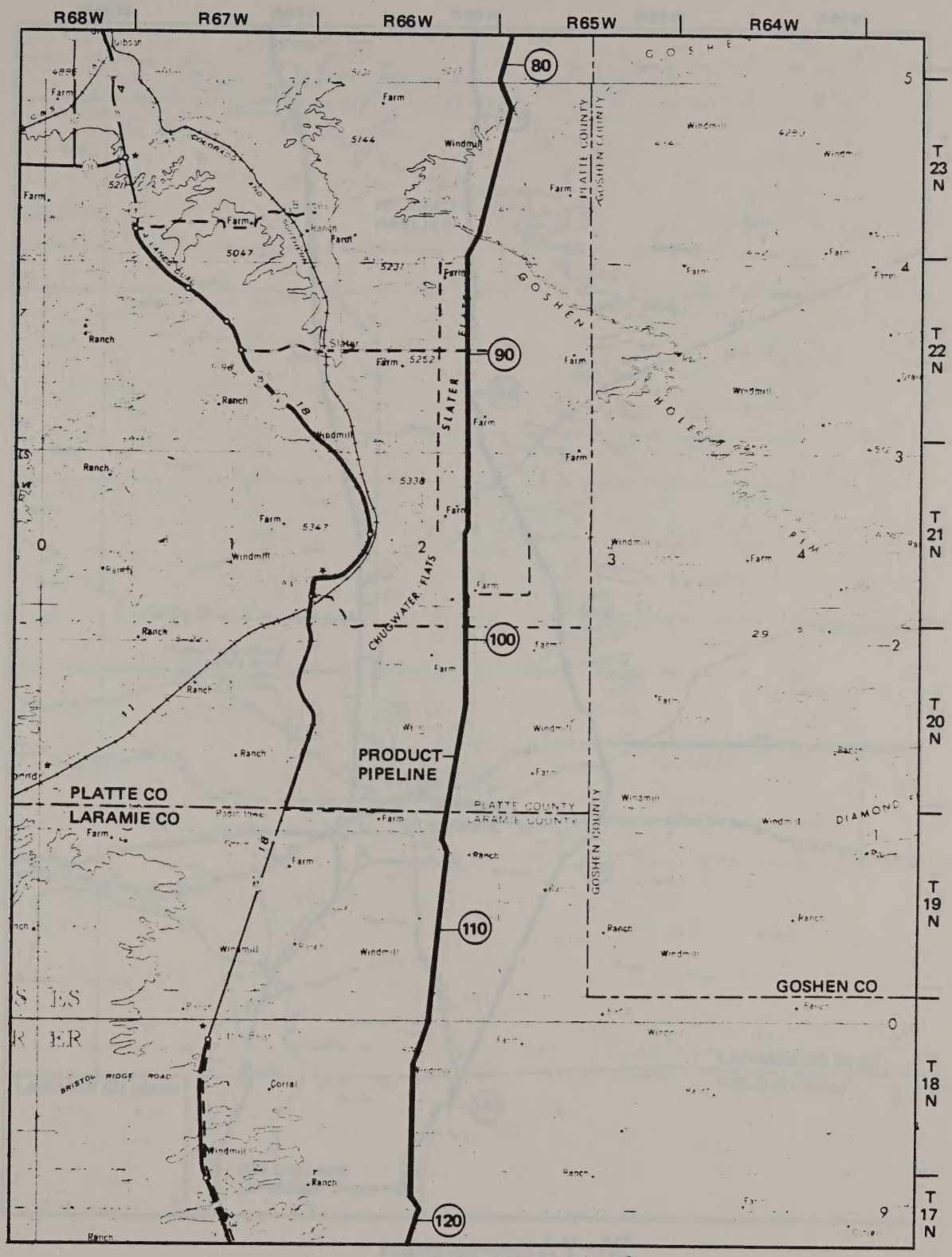


Figure ~~3.7 1(e)~~ 1.4-11
PRODUCT PIPELINE LOCATION

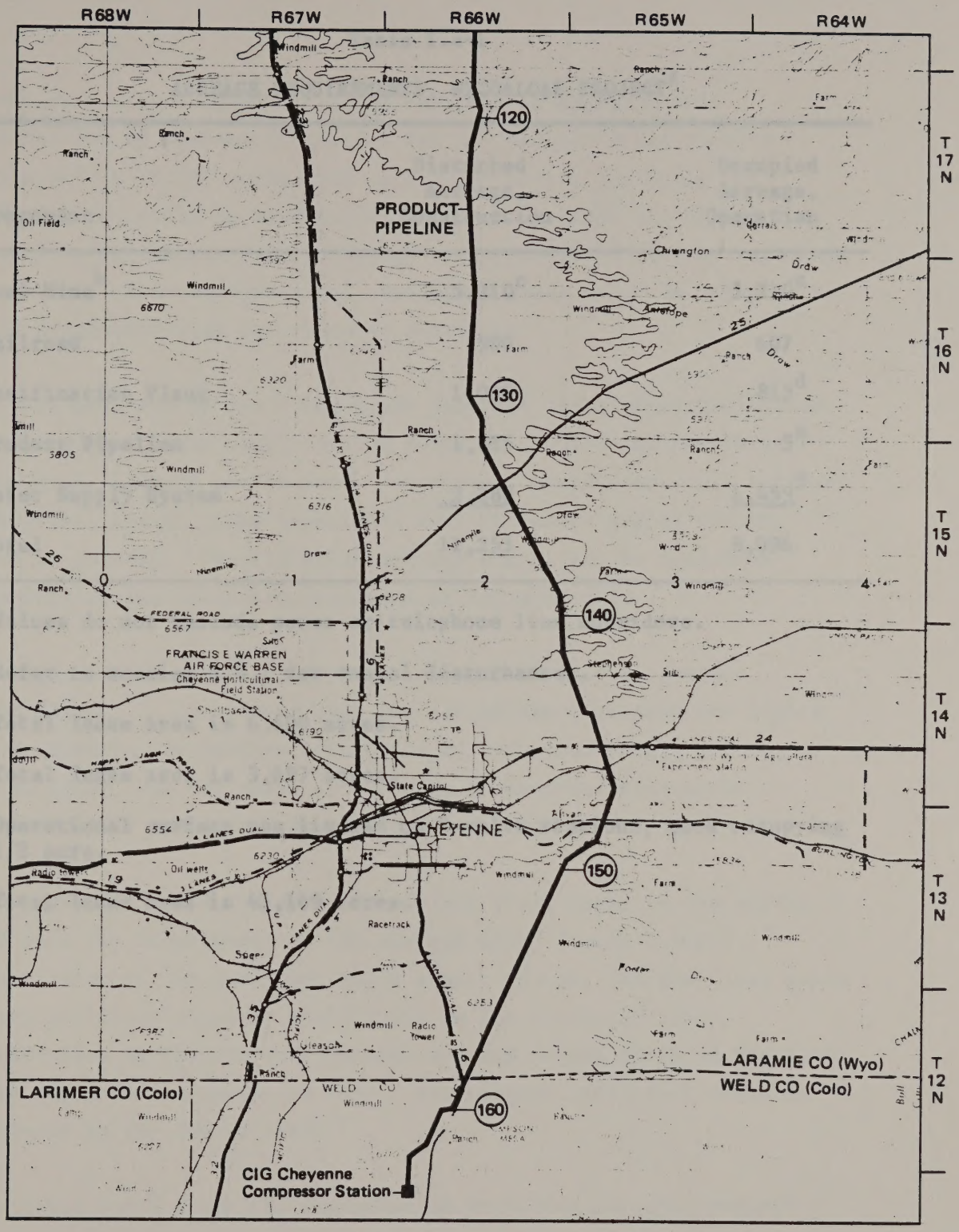


Figure ~~3.7-1(d)~~ 1.4-12
PRODUCT PIPELINE LOCATION

Table 1.4-1

ACREAGE REQUIREMENTS, WYCOALGAS PROJECT[a]

Component	Disturbed Acreage, Construction	Occupied Acreage, Operation
Coal Mine[b]	5,210[c]	5,210[c]
Railroad	900	607
Gasification Plant	1,000	815[d]
Product Pipeline	1,855	5[e]
Water Supply System	2,288	1,459[f]
Total	11,253	8,096

[a]Values do not include power or telephone line corridors.

[b]Refer to section 3.4.1 for annual disturbances.

[c]Total lease area is 6,600 acres.

[d]Total lease area is 3,697 acres.

[e]Operational surface use limited to 9 valve stations, each occupying 1/2 acre.

[f]Total lease area is 43,169 acres.

Table 1.2-1

ACREAGE REQUIREMENTS, WYOMING PROJECT[a]

Component	Disturbed Acreage, Construction	Occupied Acreage, Operation
Coal Mine[b]	3,210[c]	5,210[c]
Railroad	900	607
Gasification Plant	1,000	815[d]
Product Pipeline	1,855	9[e]
Water Supply System	2,384	1,479[f]
Total	13,353	8,099

[a]Values do not include power or telephone line corridors.

[b]Refer to section 3.4.1 for onsend disturbances.

[c]Total lease area is 6,000 acres.

[d]Total lease area is 3,697 acres.

[e]Operational surface use limited to 9 valve stations, each occupying 1/2 acre.

[f]Total lease area is 41,169 acres.

immediately after construction, as outlined in Appendix A-1. Construction of surface facilities for the project would require approximately 10,108 acres, but only 9,385 acres, including the surface mine, would be used during operation. Lands not occupied by surface facilities during project operation would also be reclaimed immediately after construction. Reclaimed lands would be returned to their preconstruction use wherever possible.

The land use of the 8,405 acres required for surface facilities other than the water supply system would be changed for the 30-year operational life of the project. At project termination, all surface facilities, except those associated with the water supply system, would be removed. The disturbed acreage would then be reclaimed according to the procedures outlined in Appendix A-1.

WyCoalGas proposes to sell its water rights after project termination. It is assumed that the person who purchases the rights would maintain the surface structures of the water supply system. Consequently, the 980 acres occupied by these structures would essentially be preempted permanently from other uses.

Construction of the proposed project would begin in the spring of 1982 with the development of the surface mine (Figure 1.4-13). Construction of the railroad, water supply system, and the first phase of the gasification plant would begin in the spring of 1983. Construction of the product pipeline and the second phase of the plant would begin in the spring of 1986. All project facilities would be completed by the end of 1988.

Table 1.4-2 shows the construction workforce for the proposed project. The average monthly payroll for this workforce is provided in Table 1.4-3.

immediately after construction, as outlined in Appendix A-1. Construction of surface facilities for the project would require approximately 10,108 acres, but only 9,385 acres, including the surface mine, would be used during operation. Lands not occupied by surface facilities during project operation would also be reclaimed immediately after construction. Reclaimed lands would be returned to their preconstruction use wherever possible.

The land use of the 8,665 acres required for surface facilities other than the water supply system would be changed for the 10-year operational life of the project. At project termination, all surface facilities, except those associated with the water supply system, would be removed. The disturbed acreage would then be reclaimed according to the procedures outlined in Appendix A-1.

Wyoming's procedure to sell its water rights after project termination, is to assume that the person who purchases the rights would maintain the surface structures of the water supply system. Consequently, the 940 acres occupied by these structures would essentially be preempted permanently from other uses.

Construction of the proposed project would begin in the spring of 1982 with the development of the surface mine (Figure 1.4-13). Construction of the railroad, water supply system, and the first phase of the pelletization plant would begin in the spring of 1982. Construction of the product pipeline and the second phase of the plant would begin in the spring of 1986. All project facilities would be completed by the end of 1988.

Table 1.2-2 shows the construction workforce for the proposed project. The average monthly payroll for this workforce is provided in Table 1.4-3.

Figure 1.4-13

CONSTRUCTION SCHEDULE, WYCOALGAS PROJECT

	Year							
	1982	1983	1984	1985	1986	1987	1988	1989
Mine								
Railroad								
Plant, 1st Phase								
Plant, 2nd Phase								
Water System								
Product Pipeline								

Figure 1.4-45

CONSTRUCTION SCHEDULE, WYOMING'S PROJECT

	Years							
	1982	1983	1984	1985	1986	1987	1988	1989
Mine								
Railroad								
Plant, 1st Phase								
Plant, 2nd Phase								
Water System								
Produce Pipeline								

TABLE 1.4-2

APPROXIMATE AVERAGE WYCOALGAS PROJECT WORKFORCE BY YEAR[a]

	1982	1983	1984	1985	1986	1987	1988	1989
Surface Mine								
Construction	137	199	--	--	--	--	--	--
Operation	--	--	105	140	184	239	251	255
Railroad								
Construction[b]	--	80-155[b]	80-155[b]	--	--	--	--	--
Operation	--	--	--	40	40	40	40	40
Gasification Plant								
Construction[c]	--	495	1,861	3,044	2,479	2,578	583	--
Operation	--	12	25	98	481	786	936	1,045
Product Pipeline								
Construction[d]	--	--	--	--	123[d]	--	--	--
Operation	--	--	--	--	2	2	2	2
Water Supply System								
Construction[e]	--	210	248	56	--	--	--	--
Operation	--	--	--	--	16	16	16	16
Total								
Construction[f]	137	984-1,059	2,189-2,264	3,100	2,602	2,578	583	--
Operation	--	12	130	278	723	1,081	1,205	1,358

[a]Assumes schedule in Figure 3.2-1.
[b]Varies seasonally.
[c]Peak plant construction workforce of _____.
[d]Peak pipeline construction workforce of 245, duration 6 months.
[e]Peak water system construction work force of 450.
[f]Peak overall construction workforce of _____.

[illegible]

[illegible]

[illegible]

TABLE 1.4-3

APPROXIMATE AVERAGE MONTHLY PAYROLLS, WYCOALGAS PROJECT (Thousands of 1981 dollars)[a]

	1982	1983	1984	1985	1986	1987	1988	1989
Surface Mine								
Construction	725	850	--	--	--	--	--	--
Operation	--	--	245	300	400	552	552	552[b]
Plant and Facilities[c]								
Construction	--	2,346	7,019	10,318	8,251	8,581	1,299	--
Operation	--	--	--	--	--	--	--	3,300
Product Pipeline								
Construction	--	--	--	--	260	--	--	--
Operation	--	--	--	--	10	10	10	10
Total								

[a]Based on schedule in Figure 3.2-1.
[b]Expected to remain constant through 1995, then gradually increase to 1,060 in peak year (expected no sooner than 2 009).
[c]Includes water system and railroad.

Project Components

This section summarizes the construction, operation, and maintenance of the major facilities of the coal gasification project. A more detailed discussion of these activities is provided in the Project Description Technical Report (WCC 1981a).

Coal Gasification Plant

The proposed coal gasification plant would be located in Converse County, Wyoming, approximately 16 miles northeast of Douglas (Figure 1.4-2). Lurgi and, to a lesser extent, Texaco gasification technologies would be used to produce a nominal 300 MMSCFD of SPF (at full production) with a heating value of 950 to 960 Btu per standard cubic foot. At full production, the plant would produce the equivalent of approximately 300 billion Btu per day or 100 trillion Btu per year.

Plant facilities would include offices, shops, medical facilities, fire protection system, water system, sewers, roads, and other support systems. Electric power for plant operations would be generated onsite using four coal-fired boilers. Plant facilities would occupy approximately 815 acres of the 3,697-acre plant site. Under agreements with the landowners, any land not used for facilities within the plant site would be leased back to the owners for grazing.

The plant layout is shown in Figures 1.4-14 and 1.4-15. An artist's conception of the completed plant, as seen approximately two miles away on State Highway 59, is provided in Figure 1.4-16. Access to the plant would be via State Highway 59, approximately 1.5 miles of County Road 55, and a private road to be constructed within the plant site boundary.

Project Description

This section summarizes the construction, operation, and maintenance of the major facilities of the coal gasification project. A more detailed discussion of these activities is provided in the Project Description Technical Report (WCC 1981a).

Coal Gasification Plant

The proposed coal gasification plant would be located in Converse County, Wyoming, approximately 16 miles northeast of Douglas (Figure 1.4-2). Using and, in a lesser extent, Texaco gasification technologies would be used to produce a nominal 250 MMSCFD of SNG (at full production) with a heating value of 970 to 980 Btu per standard cubic foot. At full production, the plant would produce the equivalent of approximately 250 million Btu per day or 100 trillion Btu per year.

Plant facilities would include offices, shops, medical facilities, coal preparation areas, water system, sewers, roads, and other support systems. Electric power for plant operations would be generated on site using four coal-fired boilers. Plant facilities would occupy approximately 815 acres of the 3,497-acre plant site. Under agreements with the landowners, any land not used for facilities within the plant site would be leased back to the owners for grazing.

The plant layout is shown in Figures 1.4-14 and 1.4-15. As access's connection of the completed plant, as seen approximately two miles away on State Highway 59, is provided in Figure 1.4-16. Access to the plant would be via State Highway 59, approximately 1.5 miles of County Road 35, and a private road is to be constructed within the plant site boundary.

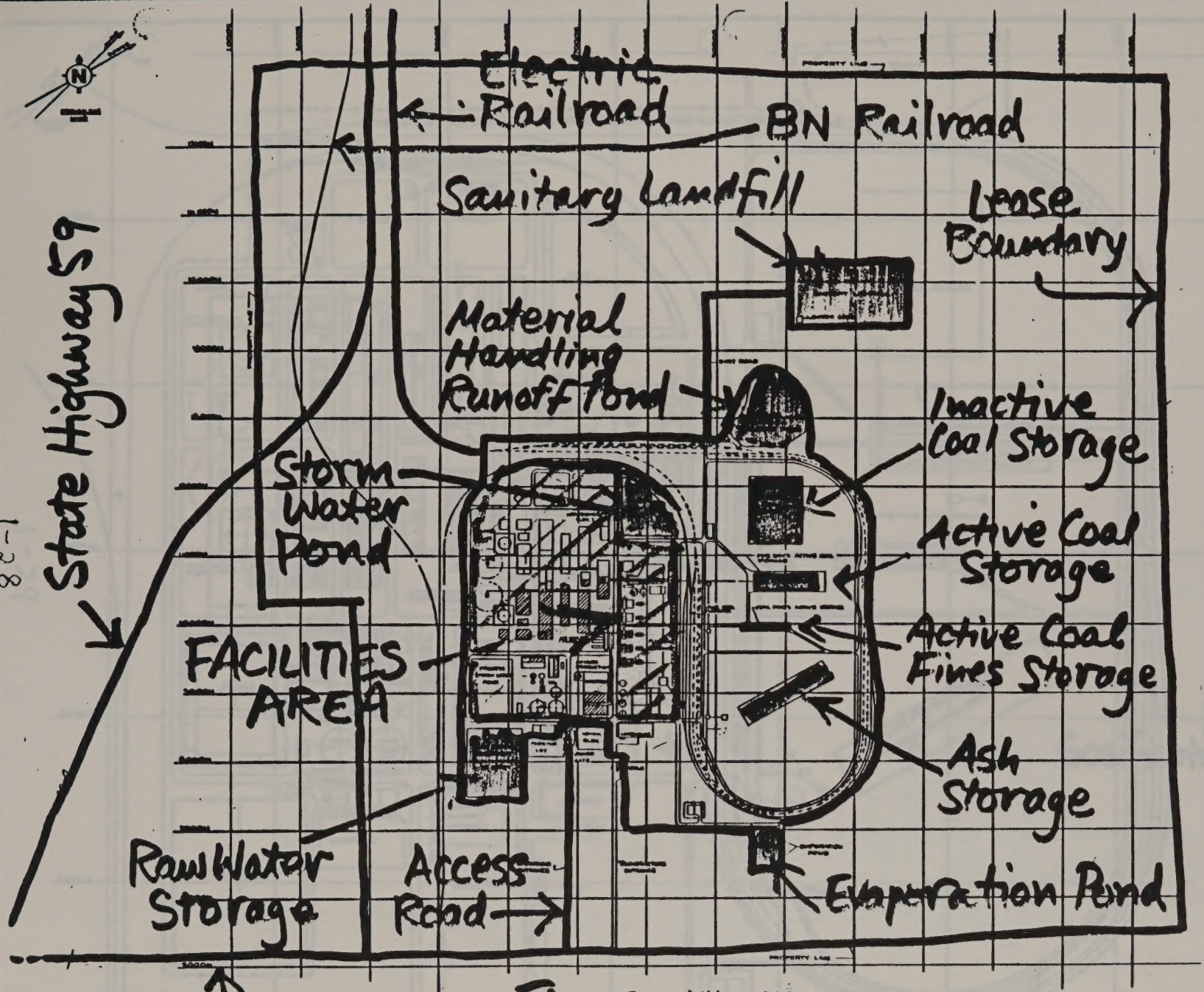


Figure 1.4-14
Gasification Plant Site

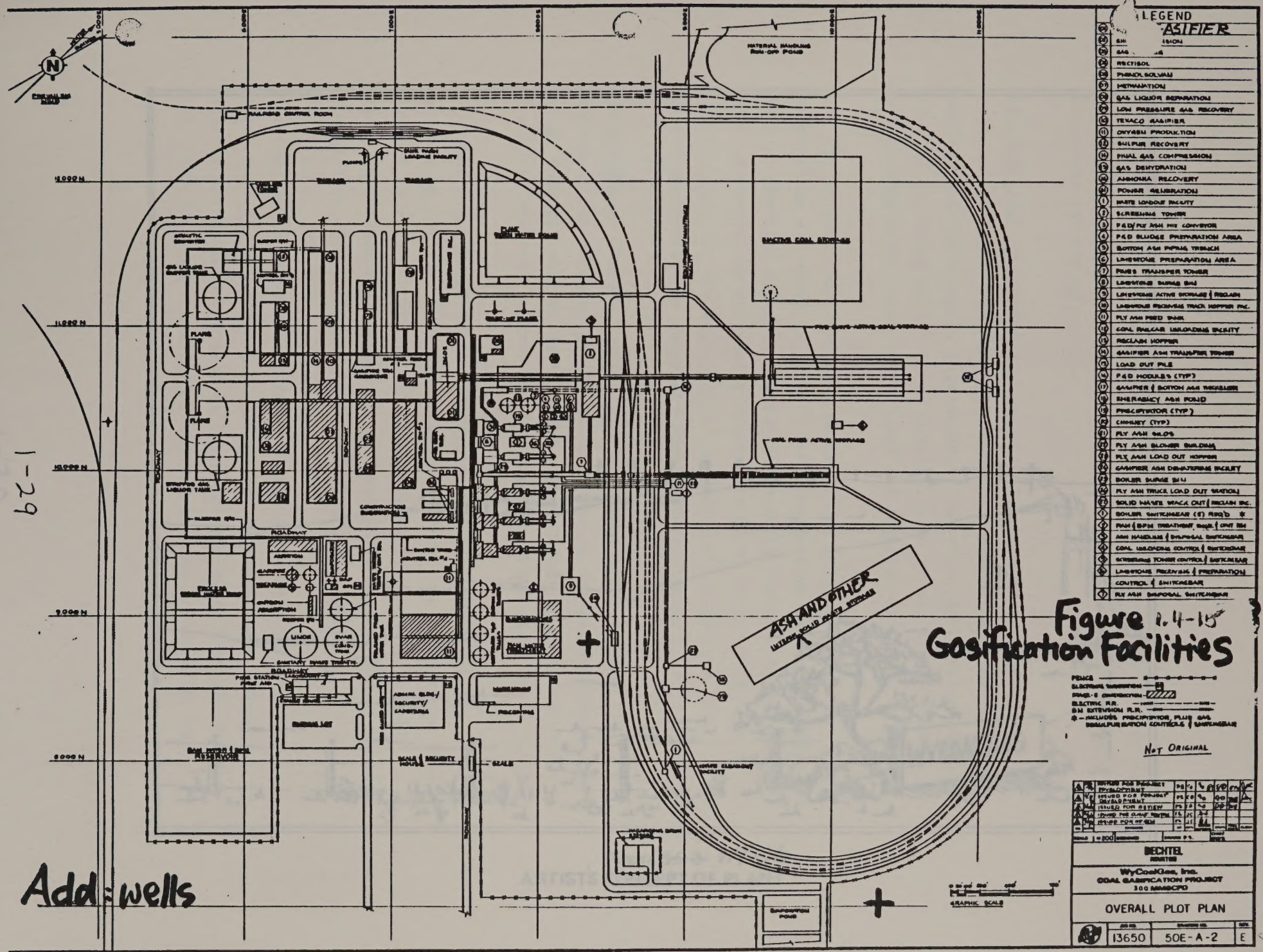


Figure 1.4-15
Gasification Facilities

Add = wells

1-29

Figure ~~3.3.3~~ 1.4-16
ARTISTS CONCEPT OF PLANT

A list of the streams within the plant site boundary is provided in Appendix A-2. All streams on the site have flows of less than 5 cubic feet per second (cfs).

Coal Gasification Chemistry. Coal gasification is accomplished in a series of chemical reactions in which the carbon in coal ultimately combines with hydrogen to form methane, the principal constituent of SPG. In the Lurgi gasification process, most of the hydrogen is derived from water, both in the coal and injected as steam.

The primary reactions that occur in the process of coal gasification are shown in Table 1.4-4. Combustion and gasification of the coal produces a mixture of carbon monoxide (CO) and hydrogen (H_2). Shift conversion catalytically shifts the CO/H_2 ratio of the gas to a mixture ideal for the methanation reactions, which produce SPG. Several noncombustible gases are also produced (Table 1.4-5).

Process Units. Figure 1.4-17 provides a simplified process flow diagram of the proposed gasification plant. A summary description of the process and support units shown in the figure is provided below. An overall material balance for the plant is provided in Table 1.4-6.

Coal from the Rochelle mine would arrive at the plant in bottom-dump rail cars. It would be loaded into two hoppers and then conveyed to either a 5-day, 165,000-ton-capacity covered storage bunker or a compacted storage pile, designed to provide for unexpected periods when coal could not be delivered from the mine.

Coal would be reclaimed from storage at an average rate of 32,600 tons per day (TPD) and screened to separate minus 1/8-inch material which cannot be used in the Lurgi gasifiers from gasifiable coal. The large coal fraction (from 1/8 inch to 3 inches in size)

TABLE 1.4-4

PRIMARY GASIFICATION REACTIONS, LURGI PROCESS

Combustion:

$C + O_2 = CO_2$ + heat

Gasification:

$C + HO = CO_2 + H_2$ + heat (water-gas reaction)

Shift Conversion:

$CO + H_2O = CO_2 + H_2$ + heat

Methanation:

$CO + 3H_2 = CH_4 + H_2O$ + heat

$CO_2 + 4H_2 = CH_4 + 2H_2O$ + heat

Minor Reactions:

Coal = $C + CH_4$ + other gases + heat (carbonization)

$C + 2H_2 = CH_4$ + heat (hydrogasification)

TABLE 1.4-5

PRODUCT GAS COMPOSITION

Component	Vol. %
Hydrogen	3.20
Methane	95.20
Carbon Dioxide	0.58
Carbon Monoxide	0.01
Argon plus Nitrogen	1.01
TOTAL	100.00

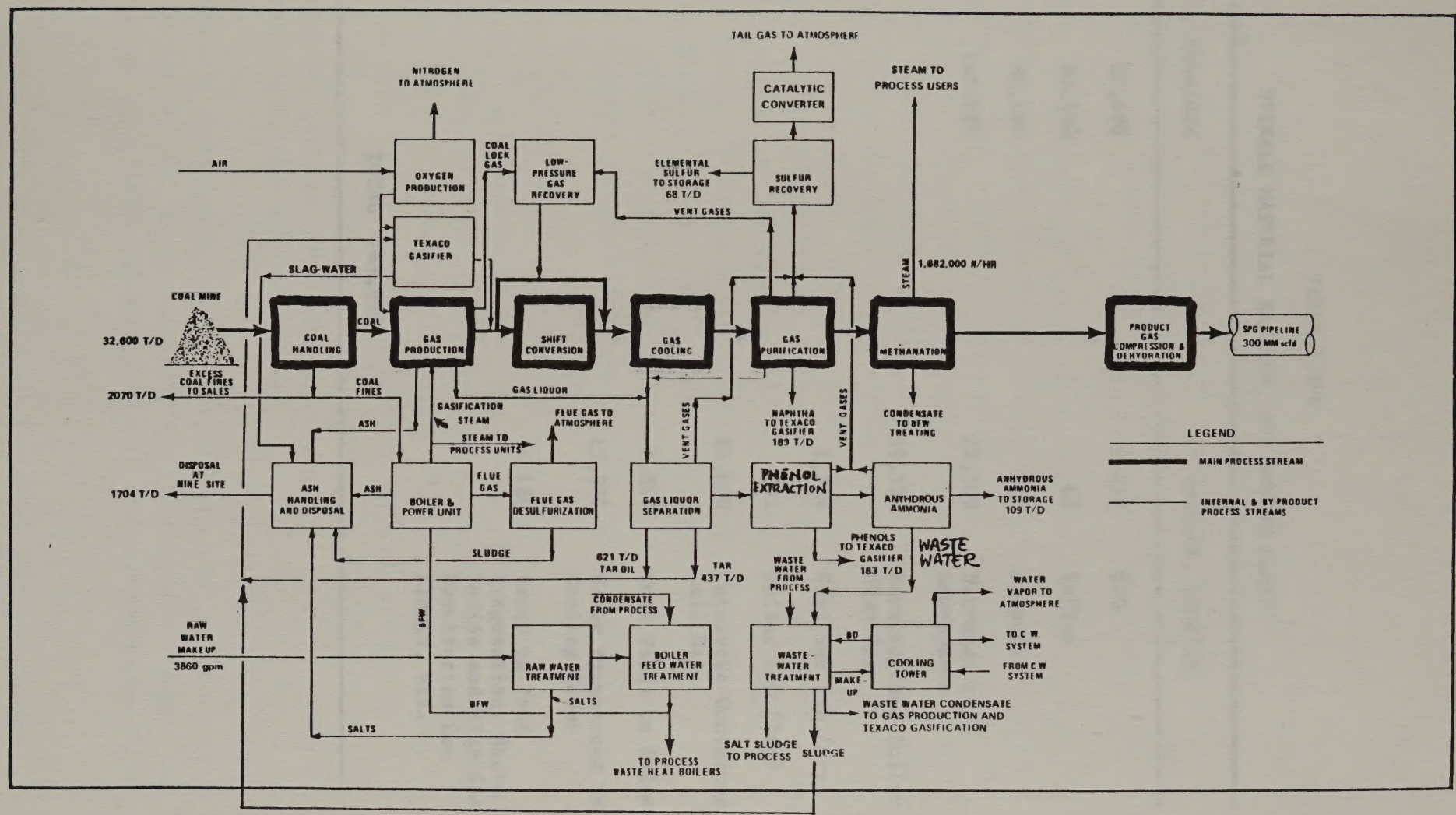


Figure 1.4-17
SIMPLIFIED PROCESS FLOW DIAGRAM
FOR COAL GASIFICATION

TABLE 1.4-6

OVERALL MATERIAL BALANCE, 300 MMSCFD PLANT

Inputs, tons/day		Outputs, tons/day	
Coal	32,600	6,538	SPG
Air	90,160	68	Sulfur
Water	23,160	108	Ammonia
TOTAL	145,920	22,500	Nitrogen to Atmosphere
		69,330	Desulfurized Boiler Flue Gas
		1,274	Gasifier Ash (Dry)
		431	Boiler Ash (Dry)
		28,630	Catalytic Converter Tail Gas
		2,070	Coal Fines to Sales
		13,200	Water Evaporated in Cooling Tower
		4,180	Water to Pond Evaporation, Waste Solids and Flue Gas Desulfurization Sludge, etc.
	TOTAL 145,920		

would be gasified at a rate of 22,820 TPD. Approximately 7,710 TPD of coal fines would be burned in the plant boilers for steam production. The remaining excess coal fines would be loaded into rail cars and sold to a local power station (this market has not yet been identified). The overall plant coal balance is shown in Table 1.4-7.

Thirty-two Lurgi coal gasifiers, four of which would normally serve as spares, would be used to produce 278 MMSCFD of gas. Coal, charged at the top of each gasifier, slowly moves downward and would be dehydrated (heated to drive off water), devolatilized (heated to drive off hydrocarbon oils, etc.), gasified (reacted with oxygen and steam to produce raw gas), and emptied into an ash hopper at the bottom of the gasifiers. Crude gas from the gasifiers contains hydrogen and carbon monoxide in a ratio of about 2:1, along with other gases. Some of the carbon and carbon oxides react with hydrogen to produce methane, while other trace fractions produce ammonia, hydrogen sulfide, phenols, napthas, and tar oils. Heat produced in gasification would be recovered, where feasible, for generation of steam and process heat to improve overall process efficiency.

The crude gas would be stripped of most of its water, tar, tar oil, phenols, hydrogen sulfide, and ammonia and then transported to two parallel trains of shift reactors. Approximately 51 percent of the crude gas would be subjected to shift conversion in these reactors. In this process, the carbon monoxide would catalytically reacted with steam to produce additional hydrogen and carbon dioxide. The remaining crude gas bypasses shift conversion and would be mixed with the shifted gas following cooling.

Gas from shift conversion and the gasifiers would be cooled in two parallel trains. A large quantity of hot gas liquor (water), tar, and oil containing small quantities of coal dust would condense from

TABLE 1.4-7

OVERALL 300 MMSCFD PLANT COAL BALANCE

	Tons/Stream Day	Tons/Year
Coal from Mine	32,600	10,828,000
Coal to Gasifiers	22,820	7,580,000
Coal to Boilers	7,710	2,561,000
Subtotal	30,530	10,141,000
Coal Fines to Sales	2,070	687,000
TOTAL	32,600	10,828,000

the gases as they cool. These liquids would be routed to the gas liquor separation unit where the liquors from the Lurgi gasifiers and the gas cooling unit would be separated into oil, gas liquor, and tar. Further processing of these three streams is discussed later in this subsection.

Gases from the gas cooling unit would be purified to reduce sulfur compounds to about 0.1 part per million (ppm), naptha, and carbon dioxide. The purified gas would then enter the methane synthesis unit where the methane content of the gas would be increased by catalytic conversion of a portion of the carbon dioxide and virtually all of the carbon monoxide and hydrogen to methane. Methane from this unit would be compressed and discharged into the product pipeline for shipment to PEPL markets.

Gas liquor, which consists of phenol, acid gas (carbon monoxide and hydrogen sulfide), ammonia, and water, from the gas liquor separation unit would be contacted with diisopropyl ether in multistage counter-current extractors (Lurgi Phenosolvan process) to remove phenol. Ammonia and acid gas would be reclaimed from the gas liquor in nitrogen stripper columns. The ammonia recovered from the columns would be stored in liquid form and ultimately sold as a byproduct of coal gasification (markets for this byproduct have not yet been determined). The acid gas would be routed to the Stretford sulfur recovery unit. The water reclaimed from the gas liquor would be recycled.

Acid gases from the Lurgi Phenosolvan process and the gas purification unit would be treated by the Stretford process to remove hydrogen sulfide and convert it to elemental sulfur. The Stretford unit for the plant has been designed to reduce the hydrogen sulfide concentration of the final tail gas to less than 100 ppm. Molten

sulfur recovered by this process would have a purity of at least 99.5 percent. This sulfur would be sold as a byproduct of coal gasification (markets for this byproduct have not yet been determined).

The phenols, naptha, tar, and tar oil recovered from the Lurgi gasifiers, gas liquor separation unit, and gas purification unit (approximately 120,000 pounds per hour) would be routed to the Texaco Synthesis Gas Generation Unit for gasification. In this unit, the liquid hydrocarbons are mixed with steam, water, and oxygen to produce synthesis gas and ash. The synthesis gas consists of hydrogen and carbon monoxide in a ratio of approximately 0.8:1.0 along with small amounts of other gases including methane, nitrogen, argon, water, and hydrogen sulfide. Synthesis gas is mixed with the crude gas from the Lurgi gasifiers to produce an additional 22 MMSCFD of SPG.

Steam and Power Generation. Steam generated by waste heat available in the methanation step and from coal-fired boilers would be used for:

- gasification reactant, temperature moderator, and process heat
- motive power for pumps and compressors
- electric power generation
- liquid fuel dispersion in burners
- freeze protection

Five boilers, each with a capacity of 1 million pounds (lb) of steam per hour and three 35-megawatt turbogenerators would be used in the

plant. All units would normally operate at 70 to 80 percent capacity. This would provide sufficient reserve capacity to avoid a plant shutdown should one of the units fail.

Cooling Water System. The proposed project has been designed to maximize air cooling in order to reduce water requirements. For example, the gas cooling unit has been designed for efficient use of waste heat that otherwise would be rejected to the atmosphere and cooling water. Steam turbines used in the plant would be equipped with air-cooled surface condensers. Condensate would be returned to the boiler feedwater system.

The cooling water system would circulate 75,000 gallons per minute (gpm) of water for use in plant processes requiring an operating temperature lower than 130°F. Since the plant has been designed for zero aqueous discharge, multi-cell, force-draft cooling towers would be used to evaporate potential effluent streams. Make-up water for the cooling towers would come primarily from the Phenosolvan unit after bio-oxidation, and evaporation. Biocides, corrosion inhibitors, and pH control chemicals would be added to the circulation water to keep corrosion and fouling effects within acceptable operating limits. No chromates would be used in the water. Tower blowdown would be discharged to the evaporation system described later in this section.

Plant Flare System. Emergency pressure reliefs would be routed into the flare system. Design load has been based on the emergency relief of total crude gas production. The flare would be designed for smokeless operation.

Tankage. A summary of tankage required for the plant is provided in Table 1.4-8. Tankage containing volatile liquids would be equipped

Table 1.4-8

SUMMARY OF THE STORAGE FACILITIES OF THE WYCOALGAS COMPLEX

Stored Materials	Storage Vessel Capacity (gal.)	Number of Vessels	Storage Temperature °F	Type of Storage Vessel
		RAW MATERIALS		
No. 2 Fuel Oil	30,000	2	Ambient[a]	Fixed Roof[b]
Liquid Oxygen	1,350 tons	2	Refrigerated	-[c]
50% Sodium Hydroxide (Aqueous Solution)	31,500	2	Ambient	Fixed Roof
Methanol	252,000	2	Ambient	Fixed Roof/Vapor Recycled to Gasification Complex
Di-isopropyl Ether	31,500	2	Ambient	Fixed Roof with Vapor Recovery System
Propylene	33,600	2	Ambient	Pressurized Tank
Triethylene Glycol	10,000	1	Ambient	Fixed Roof
Sulfuric Acid	20,000	1	Ambient	Fixed Roof
Phospheric Acid	10,000	1	Ambient	Fixed Roof
		PRODUCED MATERIALS		
Anhydrous Ammonia	5,000 tons	2	Refrigerated	-
Molten Sulfur	1,000 tons	2	-	Fixed Roof
Slop Oil[d]	4,700	2	Ambient	Fixed Roof
Crude Phenols[d]	462,000	2	140	Fixed Roof
Naphtha[d]	630,000	2	100	Floating Roof
Tar[d]	1,092,000	2	160	Fixed Roof
Tar Oils[d]	1,680,000	2	100	Fixed Roof

[a]55°F is the average annual temperature.

[b]Fixed roof implies fixed roof with a conservation vent.

[c]Vessel specification not included in petroleum storage vessel performance standards.

with floating roofs to prevent escape of vapors to the atmosphere. Propylene would be stored in pressure vessels. Anhydrous ammonia would be stored in refrigerated tanks. Dikes would be provided around tanks to contain spills. Drain hubs would be provided adjacent to these tanks to permit drainage to the oily waste sewer for treatment and reclamation, or disposal.

Waste Water Recovery, Treatment, and Reuse. The principal waste water streams and their constituents are listed in Table 1.4-9. A schematic diagram for the treatment system for these streams is provided in Figure 1.4-18.

Storm water runoff from the plant site would be collected in three ponds: (1) process storm water pond, (2) plant yard storm water pond, and (3) material handling runoff pond. Pertinent characteristics of these ponds are provided in Table 1.4-10. The plant yard storm water pond would collect runoff from the central section of the plant site where the boilers, coal screening facilities, offices, and parking lot would be located. The material handling runoff pond would collect runoff from within the plant rail loop. Since the water entering these two ponds are not expected to contain any hazardous materials, the ponds would not be lined. The process storm water pond would collect water along the western side of the plant site where the gasification and gas purification units and tankage would be located. Water entering this pond could potentially contain hazardous materials; consequently, the pond would be lined in accordance with Resource Conservation and Recovery Act (RCRA) specifications.

Water from these three ponds, and an oily water sewer installed at all areas subject to possible leaks of oily materials, would be discharged to a two-step mechanical pretreatment unit. This unit

TABLE 1.4-9

QUANTITY AND NATURE OF MAJOR WASTE WATER STREAMS

Stream	Volume (gpm)	Wastewater Constituents
Phenosolvan Effluent	3,000	High in NH_3, H_2S, high- and low-boiling organics, fatty acids, and dissolved solids.
Oil Sewer	160	Oily with suspended solids.
Sanitary Waste	25	Municipal sewage.
Storm and Fire Water	80	Suspended solids.
Selected Blowdowns	440	Non-oily, with moderate dissolved solids.

TABLE 1.4-10

CHARACTERISTICS OF PLANT WASTE PONDS[a]

Pond	Storage Size (acres)	Storage Capacity (acre-feet)	Rate of Discharge to Treatment (gpm)	Drainage Area (acres)	Expected Contaminants	Liner[b]
Process Storm Water	10	150	280	180	Spills from gasification and gas purification units and tankage	- 12" compacted soil - 80-mil polyethylene liner - Perforated PVC pipe seepage collection system set in 12" of drain rock - 12" compacted clay - Suction lysimeter
Plant Yard Storm Water	9	67	80	130	Suspended solids	Compacted soil
Materials Handling Runoff	20	244	190	340	Suspended solids	Compacted soil
Solar Evaporation	1.75	7	none	-[c]	Hot alkaline flush: - 1% trisodium phosphate - 0.05% Bennoz 2A1 - 0.05% Rohm & Haas +101 - 10 ppm Dow-Corning Anh - foam B Acid cleaning solution: - 2% hydroxyacetic acid - 1% formic acid - 0.25% inhibitor - 0.25% wetting agent - 0.25% ammonium B fluoride	Same as Process Storm Water Pond

[a]All ponds designed to contain 2.5 times the amount of water generated by a 10-year, 24-hour rainfall event. All ponds have 3:1 slopes. All ponds have 3 feet of freeboard.

[b]Liner described from top to bottom.

[c]This pond would not collect surface water runoff.

TABLE 5.4-12

CHARACTERISTICS OF PLANT WASTE PONDS[a]

Pond	Storage Size Required	Storage Capacity (acre-feet)	Size of Dikes to Prevent Freeboard (ft)	Maximum Area (acres)	Expected Contaminants	Liner[b]
Process Alone Water	10	120	240	180	Spills from pesticide-carbon and gas purification units and leakage	- 12" compacted soil - 20-mil polyvinylchloride liner - Perforated PVC pipe drainage collection system set in 12" of crushed rock - 12" compacted clay - Double liners
Plant Yard Drain Water	9	67	80	120	Suspended solids	Compacted soil
Materials Handling Runoff	20	244	180	340	Suspended solids	Compacted soil
Solar Evaporation	1.75	7	none	[c]	Hot alkaline flush: - 1% trisodium phosphate - 0.01% Benzo [a] - 0.005% Zoba & Bear [101] - 10 ppm Bar-Cleaning Sub - Ibma 4 Acid cleaning solution: - 1% hydroxyacetic acid - 1% formic acid - 0.1% inhibitor - 0.1% wetting agent - 0.1% ammonium 2 fluoride	None as Process Alone Water Pond

[a]All ponds designed to contain 1.5 times the amount of water generated by a 10-year, 24-hour rainfall event. All ponds have 1:1 slopes. All ponds have 3 feet of freeboard.

[b]Liner described from top to bottom.

[c]This pond would use collect surface water runoff.

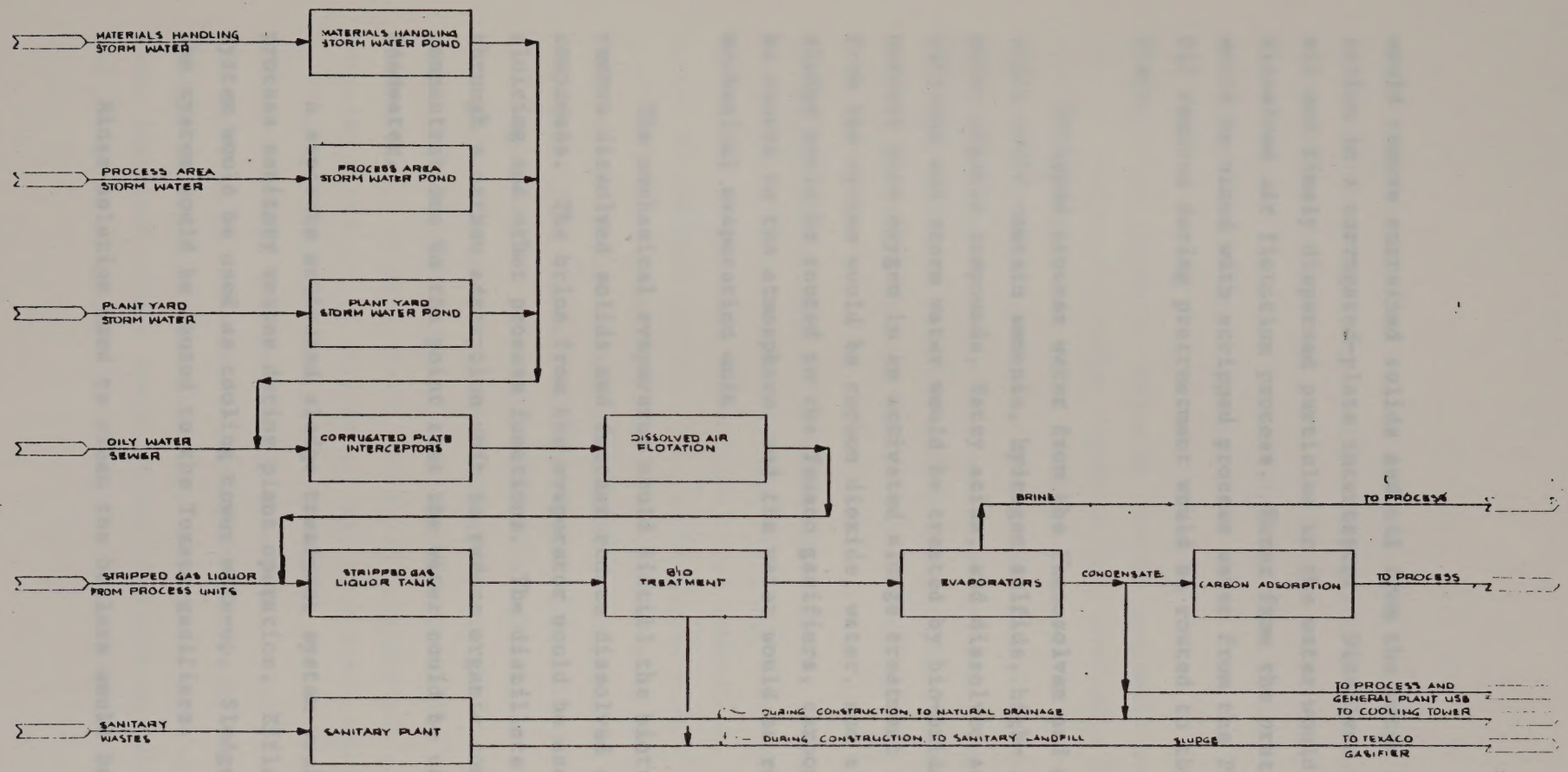


Figure 1.4-18
Wastewater and Stormwater Treatment System, Gasification Plant

would remove entrained solids and oil from the water by gravity separation in a corrugated-plate interceptor. Dissolved and emulsified oil and finely dispersed particles in the water would be removed by a dissolved air flotation process. Water from the pretreatment unit would be mixed with stripped process water from the Phenosolvan unit. Oil removed during pretreatment would be routed to the Texaco gasifiers.

Stripped process water from the Phenosolvan and other process units would contain ammonia, hydrogen sulfide, high- and low-boiling-point organic compounds, fatty acids, and dissolved solids. This effluent and storm water would be treated by bio-oxidation, using 98 percent pure oxygen in an activated sludge treatment system. Outputs from the system would be carbon dioxide, water, and sludge. The sludge would be routed to the Texaco gasifiers, carbon dioxide would be vented to the atmosphere, and the water would be routed to a mechanical evaporation unit.

The mechanical evaporator would distill the biotreated water to remove dissolved solids and further reduce dissolved organic compounds. The brine from the evaporator would be used for ash sluicing and other process functions. The distillate would be passed through a carbon adsorption unit to reduce organic compound concentrations to the point that the water could be used as boiler feedwater.

A separate activated sludge treatment system would be used to process sanitary wastes during plant operation. Effluent from the system would be used as cooling tower make-up. Sludge reclaimed from the system would be routed to the Texaco gasifiers.

Rinse solution used to clean the boilers would be discharged to a

solar evaporation pond (Table 1.4-10). The pond would contain 500,000 gallons of boiler rinse solution during the first year of plant operation and 833,000 gallons thereafter. Since the solution is classified as hazardous under RCRA, the pond would be lined according to RCRA specifications.

Air Emission Controls. Emission control equipment and procedures for all project facilities represent Best Available Control Technology (BACT). A summary of plant emission controls is provided in Table 1.4-11. For further discussion of plant emission controls, refer to the Meteorology, Air Quality, and Noise Technical Report (WCC 1981b), which is available from the BLM, Wyoming State Office, 2515 Warren Avenue, Cheyenne, Wyoming 82001, (307) 778-2220.

Solid Waste Management. The major solid wastes produced during plant operation are listed in Table 1.4-12. Lurgi gasifier ash would be similar to ash from conventional coal combustion, but with higher levels of residual carbon. The ash is gravel-sized. The Texaco gasifiers would produce a fused (vitrified) slag and fine soot composed of noncombustible materials. Boiler bottom ash is a vitrified inert residue left over from combustion of coal. It is also gravel-sized. Fly ash, which is ash entrained in flue gas after coal firing, is a fine-grained vitrified material 10 to 100 microns in diameter. Fly ash would be removed from the boiler flue gas using electrostatic precipitators. Flue gas desulfurization (FGD) sludge is composed primarily of calcium sulfate with small amounts of calcium sulfite and calcium carbonate. FGD sludge would be produced as a result of sulfur dioxide removal from boiler flue gas in spray tower absorbers using limestone as a reagent. Cooling tower sludge would consist of soil and dust particles trapped in the cooling towers. Raw water treatment sludge would consist of dissolved solids contained in the raw process water. It is expected that this sludge would contain

solar evaporation pond (Table 1.4-10). The pond would contain 300,000 gallons of boiler rinse solution during the first year of plant operation and 220,000 gallons thereafter. Since the solution is classified as hazardous under RCRA, the pond would be lined according to RCRA specifications.

Air Pollution Controls. Emission control equipment and procedures for all project facilities represent Best Available Control Technology (BACT). A summary of plant emission controls is provided in Table 1.4-11. For further discussion of plant emission controls, refer to the Meteorology, Air Quality, and Noise Technical Report (WCC 1981b), which is available from the BLM, Wyoming State Office, 2515 Warren Avenue, Cheyenne, Wyoming 82001, (307) 778-2220.

Solid Waste Management. The major solid wastes produced during plant operation are listed in Table 1.4-12. Large gasifier ash would be similar to ash from conventional coal combustion, but with higher levels of residual carbon. The ash is gravel-sized. The Texaco gasifiers would produce a fused (vitrified) slag and fine ash composed of noncombustible material. Boiler bottom ash is a vitrified inert residue left over from combustion of coal. It is also gravel-sized. Fly ash, which is ash entrained in flue gas after coal firing, is a fine-grained vitrified material 10 to 100 microns in diameter. Fly ash would be removed from the boiler flue gas using electrostatic precipitators. Flue gas desulfurization (FGD) sludge is composed primarily of calcium sulfate with small amounts of calcium sulfite and calcium carbonate. FGD sludge would be produced as a result of sulfur dioxide removal from boiler flue gas in spray tower absorbers using limestone as a reagent. Cooling tower sludge would consist of soil and dust particles trapped in the cooling towers. Raw water treatment sludge would consist of dissolved solids contained in the raw process water. It is expected that this sludge would contain

TABLE 1.4-11

SUMMARY OF EMISSION CONTROL EQUIPMENT, GASIFICATION PLANT

Emission Source or Process	Controlled Pollutants	Pollution Control Equipment or Process
Lurgi gasifier startup, preheat gases, and lock gas recovery	H_2S, Nonmethane hydrocarbons	Flare
Gas purification system offgas, acid gas from ammonia production, gas liquor, expansion gas	H_2S	Stretford unit
Stretford unit offgases	Hydrocarbons, CO, H_2S, mercaptans	Catalytic converter
Glycol regeneration	Hydrocarbons	Flare
Storage tanks containing naphtha	Nonmethane hydrocarbons and reduced sulfur compounds	Floating roof tanks
Storage tanks containing oil, phenol, tar, and gas liquor water	Nonmethane hydrocarbons, reduced sulfur compounds, and ammonia	Fixed roof tanks
Texaco gasifier startup offgases	H_2S, hydrocarbons, mercaptans	Flare
Limestone and coal handling conveyors, storage buildings, transfer points, reclaim areas	Particulates	Enclosure with baghouse filter on ventilation exhausts
Waste handling conveyors	Particulates	Enclosure
Solid waste storage piles	Particulates	Watering
Materials handling transfer points	Particulates	Telescopic chutes
Coal and coal fines reclaim	Particulates	Underground reclaim
Coal pile	Particulates	Grading, packing with crusting agents

TABLE 1.4-11

SUMMARY OF EMISSION CONTROL EQUIPMENT, CLASSIFICATION PLANT

Emission Source or Process	Controlled Pollutants	Pollution Control Equipment or Process
Level gantler stretch, product gases, and lock gas recovery	H_2S, Nonmethane hydrocarbons	Flare
Gas purification system ullage, acid gas from ammonia production, gas liquor expansion gas	H_2S	Stretford unit
Stretford unit ullages	Hydrocarbons, CO, H_2S, nonmethane	Catalytic converter
Glycol regeneration	Hydrocarbons	Flare
Storage tanks containing naphtha	Nonmethane hydrocarbons and reduced sulfur compounds	Floating roof tanks
Storage tanks containing oil, phenol, tar, and gas liquor water	Nonmethane hydrocarbons, reduced sulfur compounds, and ammonia	Fixed roof tanks
Tarmac gantler stretch ullages	H_2S, hydrocarbons, nonmethane	Flare
Limestone and coal handling conveyors, storage buildings, transfer points, reclaim areas	Particulates	Enclosure with baghouse filter on reclaim areas
Waste handling conveyors	Particulates	Enclosure
Solid waste storage piles	Particulates	Watering
Material handling transfer points	Particulates	Telescopic chutes
Coal and coal fines reclaim	Particulates	Underground reclaim
Coal pile	Particulates	Crusting, packing with crusting agents

TABLE 1.4-11 Concluded

Emission Source or Process	Controlled Pollutants	Pollution Control Equipment or Process
Coal pile traffic	Particulates	Chemical dust suppressants
Coal-fired boiler	SO_2	Flue gas desulfurization system
Coal-fired boiler	Particulates	Electrostatic precipitator
Coal-fired boiler	NO_x	Burner control and overfire air
General fugitive emissions from gasification plant	Hydrocarbons, CO, trace elements	Preventive maintenance and good housekeeping practices
Coal lock exhaust gases	Hydrocarbons, reduced sulfur gases	Incineration in boiler

TABLE 1.4-11 Concluded

Emission Source or Process	Controlled Pollutants	Pollution Control Equipment or Process
Coal pile traffic	Particulates	Chemical dust suppressants
Coal-fired boiler	SO_2	Flue gas desulfurization system
Coal-fired boiler	Particulates	Electrostatic precipitator
Coal-fired boiler	NO_x	Burner control and overfire air
General fugitive emissions from gasification plant	Hydrocarbons, CO_2, trace elements	Preventive maintenance and good housekeeping practices
Coal lock exhaust gases	Hydrocarbons, reduced sulfur gases	Incineration in boiler

TABLE 1.4-12

MAJOR SOLID WASTES FROM
300 MMSCFD GASIFICATION PLANT

Solid Wastes to Mine	Production Rates, tons/hour (dry)
Lurgi Gasifier Ash	54
Texaco Gasifier Slag	0.38
Fly (Precipitator) Ash	13
Boiler Bottom Ash	3
FGD Sludge	5
Cooling Tower Sludge	Infrequent
Raw Water Treatment Sludge	0.23

TABLE 1.4-12

MAJOR SOLID WASTES FROM
300 MEGW COAL-FIRED PLANT

Solid Wastes to Site	Production Rates, tons/hour (dry)
Large Cyclone Ash	54
Parade Cyclone Slag	0.38
Fly (Precipitator) Ash	13
Boiler Bottom Ash	3
FGD Sludge	5
Cooling Tower Sludge	Inferences
Raw Water Treatment Sludge	0.23

approximately 75 percent calcium salts.

Leaching tests using the RCRA extraction procedure were conducted on gasifier ash, fly (precipitator) ash, boiler bottom ash, and FGD sludge, as well as a mixture of these wastes. The results of the tests indicate that all of these wastes are classified nonhazardous under RCRA (Table 1.4-13). The raw water treatment and cooling tower sludges would also be nonhazardous under RCRA since they would contain common constituents of the soils and water in the project area.

Gasifier and fly ash as well as FGD sludge would be mixed with water and transported from the process units to dewatering facilities. After dewatering, these wastes and fly ash would either be loaded into rail cars for shipment to the mine disposal site or deposited in an interim storage area.

The rail cars used to transport solid wastes to the mine would not be used for coal handling. At a waste cleanout area adjacent to the loading facility, the cars would be periodically cleaned to remove ash lodged in them.

During the winter when ash could not be transported to the mine because of freezing temperatures, it would be stored in the interim solid waste storage basin. This basin would also be used to store ash during plant startup until the mine has been developed sufficiently to accept the ash for disposal.

The interim solid waste storage basin would have a capacity to hold 400,000 tons of ash, assuming a density of 70 lbs per cubic foot. This would allow for 12 months of storage. The basin would be 15 feet deep, 1,400 feet long, and 300 feet wide with a soil cement liner 15 inches thick. The basin would be sloped to a drain that would deliver

approximately 77 percent sulfuric acid.

Leaching tests using the TCLP extraction procedure were conducted on gasifier ash, fly (precipitator) ash, boiler bottom ash, and FGD sludge, as well as a mixture of these wastes. The results of the tests indicate that all of these wastes are classified nonhazardous under RCRA (Table 1.4-13). The raw water treatment and cooling tower sludges would also be nonhazardous under RCRA since they would contain common constituents of the soils and water in the project area.

Gasifier and fly ash as well as FGD sludge would be mixed with water and transported from the process units to dewatering facilities. After dewatering, these wastes and fly ash would either be loaded into rail cars for shipment to the mine disposal site or deposited in an interim storage area.

The rail cars used to transport solid wastes to the mine would not be used for coal handling. At a waste transport area adjacent to the loading facility, the cars would be periodically cleaned to remove ash lodged in them.

During the winter when ash could not be transported to the mine because of freezing temperatures, it would be stored in the interim solid waste storage basin. This basin would also be used to store ash during plant starting until the mine has been developed sufficiently to accept the ash for disposal.

The interim solid waste storage basin would have a capacity to hold 600,000 tons of ash, assuming a density of 70 lbs per cubic foot. This would allow for 12 months of storage. The basin would be 15 feet deep, 1,000 feet long, and 100 feet wide with a soil cement liner 15 inches thick. The basin would be sloped to a drain that would deliver

TABLE 1.4-13

RESULTS OF RCRA EP TOXICITY TESTING ON SOLID WASTES ROUTED TO THE INTERIM STORAGE AREA
(mg/l)

Contaminant	RCRA[a] Limits	Lurgi[b] Ash	Texaco Slag	Bottom[c] Ash	Precipitator[c] Ash	Scrubber[c] Sludge	Codisposal[d] Mix
Arsenic	5.0	0.023/0.011	<.0003	0.003	0.048	<0.002	0.056
Barium	100.0	4.8/3.5	0.15	0.29	0.88	<0.053	0.31
Cadmium	1.0	<0.008/<0.008	<.03	<0.008	0.025	<0.008	<0.008
Chromium	5.0	0.012/0.012	<.02	<0.001	0.33	<0.001	0.098
Lead	5.0	0.003/<0.001	<.02	0.002	0.011	<0.001	0.005
Mercury	0.2	<0.0002/<.0002		<0.0002	<0.0002	<0.0002	<0.0002
Selenium	1.0	<0.003/0.006	<.004	<0.003	0.043	<0.003	0.044
Silver	5.0	<0.002/<0.002	<.06	<0.002	<0.002	<0.002	<0.002

[a] Federal Register , May 19, 1980, pp. 33127-33129.

[b] Toxicity testing was performed on the two samples of the gasifier ash from the Sasol One (Proprietary) Ltd. test burn.

[c] Toxicity testing was performed on these wastes collected at a Wyoming power plant burning coal similar in composition to the Rochelle coal.

[d] Codisposal mix #1:

Gasifier Ash	- 71.7% (Dry Weight)
Precipitator Ash	- 17.6
Bottom Ash	- 4.3
Scrubber Sludge	- 6.4

TABLE 1.4-13

RESULTS OF RCRA EP TOXICITY TESTING ON SOLID WASTES ROUTED TO THE INTERIM STORAGE AREA
(mg/l)

Contaminant	RCRA[a] Limits	Lorpi[b] Ash	Texaco Slag	Bottom[c] Ash	Precipita-[c] tor Ash	Scrubber[c] Sludge	Coalpoxsal[d] Mix
Arsenic	5.0	0.023/0.011	<.0003	0.003	0.048	<0.002	0.055
Barium	100.0	4.8/3.5	0.15	0.24	0.88	<0.051	0.31
Cadmium	1.0	<0.004/<0.008	<.03	<0.006	0.025	<0.008	<0.008
Chromium	5.0	0.012/0.012	<.02	<0.001	0.33	<0.001	0.055
Lead	5.0	0.003/<0.001	<.02	0.002	0.011	<0.001	0.005
Mercury	0.2	<0.0002/<.0002		<0.0002	<0.0002	<0.0002	<0.0002
Selenium	1.0	<0.001/0.006	<.004	<0.003	0.043	<0.001	0.046
Silver	5.0	<0.002/<0.002	<.06	<0.002	<0.002	<0.002	<0.002

[a] Federal Register , May 19, 1980, pp. 33127-33129.

[b] Toxicity testing was performed on the two samples of the precipitator ash from the Basel Unit (proprietary) lab. test burn.

[c] Toxicity testing was performed on these wastes collected at a Wyodak power plant burning coal similar in composition to the Rochelle coal.

[d] Coalpoxsal mix #1: Precipitator Ash - 71.1% (Dry Weight)
Bottom Ash - 17.8
Scrubber Sludge - 4.3
Scrubber Sludge - 6.4

the effluent to the materials handling storm water pond.

A two-acre emergency ash pond would be used in the event of failure of the mechanical systems which dewater and convey the ash and sludge to the interim solid waste storage basin. The pond would act as an ash-settling basin until the mechanical equipment was put back into service. After normal operations are again initiated, the pond would be drained and the ash removed by front-end loaders or dump trucks to the interim storage basin. The emergency ash pond would be lined with 12 inches of reinforced concrete, and would have a capacity to hold 10 to 20 days of ash produced at a rate of 75 tons per hour.

An onsite sanitary landfill would be used for disposal of refuse generated during plant operation. It is assumed that five pounds of garbage and trash per day would be generated by each person at the plant. The landfill would be constructed and operated in accordance with Wyoming Solid Waste Management Rules and Regulations.

Hazardous and nonhazardous wastes stored in drums would be kept in a building with a concrete floor. The types of waste that would be stored and the maximum number of 55-gallon drums that would be kept onsite are as follows:

- Spent Shift Catalyst - 960 drums
- Spent Methanation Catalyst - 960 drums
- Zinc Oxide - 24 drums
- Laboratory Wastes - 72 drums
- Halogenated Waste - 24 drums
- Tank Farm Spillage - 384 drums

<u>Construction Procedures</u>. The initial plant construction effort would be devoted to grading the entire site to specified elevations

and constructing the temporary onsite work camp and facilities. After site grading has been in progress for six months, work would begin on the foundations for the phase I permanent buildings and the tankage. Three months after the start of phase I foundation work, sufficient permanent plant materials would be onsite to allow the start of phase I mechanical work. Fourteen months prior to the mechanical completions of phase I of the plant, foundations and underground pipeline and electrical work for phase II would begin. Three months after start of phase II foundation work, phase II mechanical work would start. Phase II mechanical work would take 37 months.

Major equipment that would be used in plant construction is listed in Table 1.4-14. All equipment would operate five days per week, 10 hours per day while on the jobsite.

Exterior materials and colors for plant structures would be selected to blend with the surrounding landscape as much as possible. Non-reflective materials and low-gloss paints would be used in colors equivalent to Pittsburg Paint & Glass Company "Sagebrush Grey-Green" (PPG 33) and Wilko "Sandstone". Visual contrast between the plant and the surrounding area would be reduced with landscaping techniques. Large rocks unearthed during plant construction and grading, as well as topsoil, would be stockpiled and used in landscaping.

A temporary construction camp consisting of dormitory units and a recreational vehicle (RV) park for singles and couples without children, centralized services, and recreational facilities would be located in the southeast corner of the plant site (Figure 1.4-19). Provisions would be made for up to 1,200 dormitory rooms and 600 RV spaces. Water for all camp and construction uses would be drawn from two wells (Figure 1.4-14) installed at the plant site capable of pumping 366,000 gallons per day. The water would be treated for

Table 1.4-14

MAJOR EQUIPMENT REQUIREMENTS FOR GASIFICATION PLANT CONSTRUCTION

Office Facilities	4 - Office trailers - 12' x 60'[a]
	3 - First aid trailers - 8' x 32'
	4 - Comfort trailers - 8' x 32'
	4 - Change trailers - 10' x 60'[a]
	3 - Timekeeper trailers - 10' x 35'
Job Site Transportation	1 - Sedan - 4D medium
	1 - Station wagon - heavy duty
	2 - Sedans - 4D heavy duty
	60 - Pick-ups - 1/2 ton
	3 - Pick-ups - 3/4 ton
	10 - Stake body trucks - 3/4 ton
	1 - Van - 1/2 ton suburban
	1 - Ambulance - 3/4 ton
Site work and foundations	15 - Earthmovers - 20 CY
	6 - Dozers - D9W
	2 - Dozers - D7
	2 - Dozers - D4
	10 - Dump trucks - 4 ton
	3 - sheepsfoot rollers - 20 ton
	2 - vibratory rollers - 25,000 lb
	40 - Plate tampers - 30" x 36"
	5 - Loaders/backhoes - 1 CY
	4 - Front-end loaders - 2 1/4 CY
	3 - Crawler/Excavators - 1 1/2 CY
	2 - Motor graders
	4 - Concrete buckets - 2 CY
	4 - Concrete buckets - 1 CY
Mechanical Installation	10 - Scissors scaffolds - 25' 1000 lb
	10 - Cherry pickers - 12 ton
	5 - Cherry pickers - 18 ton
	10 - Rough terrain cherry pickers - 30 ton
	1 - Rough terrain crane - 65 ton
	1 - Rough terrain crane - 80 ton
	1 - Truck crane - 80 ton
	2 - Crawler cranes - 100 ton
	2 - Crawler cranes - 155 ton
	2 - Crawler cranes - 200 ton
	1 - 4100 ringer - 36'
	1 - Tower frame - 270' - 55 ton
	5 - Air tuggers - 18" long drum
	10 - Welders - 200 amp DC
	30 - 8 - Pac welders - 200 Amp
	5 - Portable welders - 200 Amp
	3 - Portable welders - 300 Amp
Material Handling & Distribution	4 - Tractors - 4 speed gas
	4 - Flatbed trucks - 2 ton
	10 - Flatbed dump trucks - 2 ton
	5 - Farm wagons - 8 ton
	2 - Platform trailers - 30 ton
	1 - Lowbed trailer - 30 ton
	3 - Forklifts - 2500 lb
	1 - Forklift - 10,000 lb

[a]To be used only until temporary facilities are constructed.

Table 1.7-11

MAIN EQUIPMENT REQUIREMENTS FOR CONSTRUCTION PLANT CONSTRUCTION

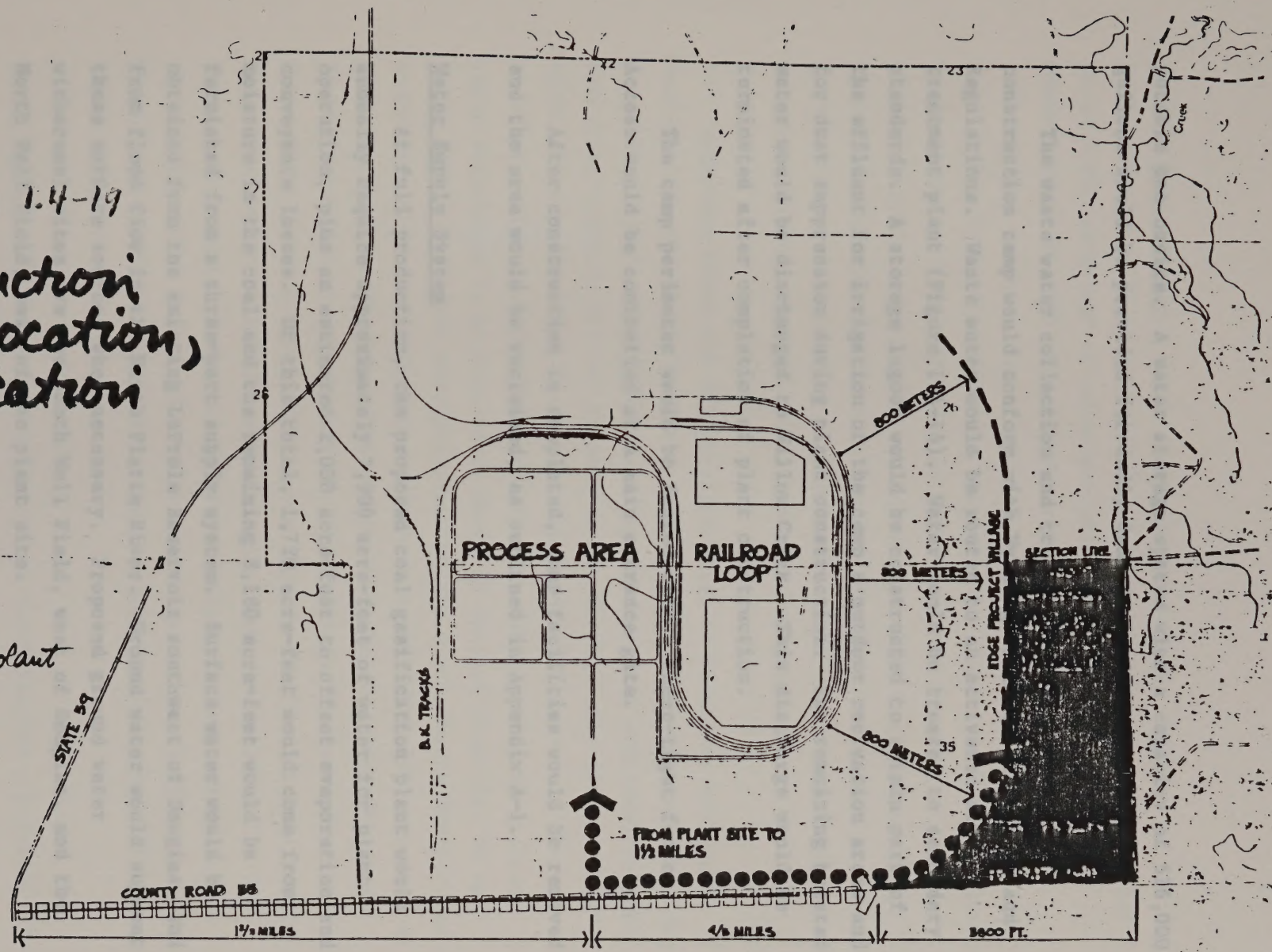
Office Facilities	4 - Office trailers - 12' x 52'*
	3 - Field aid trailers - 8' x 32'
	8 - Change room trailers - 8' x 32'
	4 - Change room trailers - 10' x 32'*
	2 - Lunchroom trailers - 10' x 32'
Job Site Transportation	1 - Sedan - 20 seating
	1 - Station wagon - heavy duty
	2 - Pickup - 1/2 heavy duty
	40 - Pickups - 1/2 ton
	2 - Vans - 3/4 ton
	10 - Crane duty trucks - 3/4 ton
	1 - Van - 1/2 ton enclosed
	1 - Ambulance - 3/4 ton
Site work and foundations	15 - Backhoes - 20 CY
	8 - Dozers - D9N
	7 - Graders - 12
	2 - Graders - 14
	10 - Dump trucks - 8 ton
	3 - Scrapers, wheel - 20 ton
	2 - Vibratory rollers - 12,000 lb
	40 - Plate tampers - 20" x 12"
	3 - Trenchers/backhoes - 1 CY
	4 - Front-end loaders - 1 1/4 CY
	7 - Hydraulic/excavators - 1 1/2 CY
	2 - Water pumps
	4 - Concrete buckets - 2 CY
	4 - Concrete buckets - 1 CY
Structural Installation	10 - Rubber wheel cranes - 25' 1000 lb
	12 - Carry pickups - 12 ton
	5 - Carry pickups - 15 ton
	10 - Rough terrain carry pickups - 15 ton
	3 - Rough terrain cranes - 45 ton
	1 - Rough terrain cranes - 80 ton
	1 - Truck crane - 80 ton
	2 - Crawler cranes - 100 ton
	2 - Crawler cranes - 125 ton
	2 - Crawler cranes - 200 ton
	2 - AIMC cranes - 35'
	2 - Tower cranes - 270' - 15 ton
	2 - Air compr - 15' long type
	10 - Welders - 200 amp DC
	70 - S - Pac welders - 300 amp
	2 - Portable welders - 300 amp
	1 - Portable welders - 400 amp
Material Handling & Distribution	4 - Forklifts - 4 stage lift
	4 - Pallet trucks - 2 ton
	10 - Flatbed dump trucks - 2 ton
	3 - Tank wagons - 5 ton
	2 - Flatbed trailers - 40 ton
	1 - Lowboy trailer - 50 ton
	1 - Portaflex - 2500 lb
	1 - Rowbalt - 12,000 lb

*To be used only until temporary facilities are constructed.

Figure 1.4-19
Construction Camp Location, Gasification Plant.

Add:

-treatment plant



1-56

potable use onsite. A water storage system with a capacity of 516,000 gallons would be provided for daily demand and firefighting.

The waste water collection and treatment system for the construction camp would conform with Wyoming Water Quality Rules and Regulations. Waste water would be routed to an activated sludge treatment plant (Figure 1.4-14). Water would be treated to secondary standards. A storage lagoon would be constructed to retain part of the effluent for irrigation of the camp's outdoor recreation areas and for dust suppression during plant construction. The remaining treated water would be discharged to Willow Creek. This discharge would be terminated after completion of plant construction.

The camp perimeter would be fenced with a sheep-tight fence. Access would be controlled at a main entrance gate.

After construction is completed, camp facilities would be removed and the area would be reclaimed, as outlined in Appendix A-1.

Water Supply System

At full production, the proposed coal gasification plant would annually require approximately 7,900 acre-feet of water for plant operation, plus an estimated 2,000 acre-feet to offset evaporation and conveyance losses. Of this total, 1,720 acre-feet would come from moisture in the coal and the remaining 8,180 acre-feet would be furnished from a three-part supply system. Surface water would be obtained from the existing LaPrele Reservoir southwest of Douglas, and from flood flow in the North Platte River. Ground water would augment these surface sources when necessary. Proposed ground water withdrawal sites are the South Well Field, west of Douglas, and the North Well Field, west of the plant site.

Surface Water Supply. Under an agreement with the Douglas Reservoirs Water Users Association, Panhandle Eastern contracted for up to 5,000 acre-feet of water per year (Wyoming State Board of Control Order No. 20) from the Association's LaPrele Reservoir in exchange for guaranteeing a loan to finance the rehabilitation of LaPrele Dam (rehabilitation was completed in 1975). Panhandle Eastern also obtained a direct flood flow right from the North Platte River with a priority date of 1974, and a storage right for this water. WyCoalGas would be able to obtain water from the river, when in priority, at a maximum rate of 201.2 cubic feet per second (cfs), not to exceed 26,539 acre-feet for storage in any year.

WyCoalGas conducted an operation study to determine the annual availability of LaPrele Reservoir and North Platte River water for the proposed project. The study basically consisted of superimposing the operating criteria for the project on the North Platte River system model developed by the Water Resources Research Institute. The modeling period was 1930 through 1979. Operating criteria included those stipulated in Wyoming State Board of Control Order No. 20 and water rights of senior appropriations on the North Platte River. The operating study indicated that an annual average of 4,610 acre-feet of water would be available to the project from LaPrele Reservoir and 11,500 acre-feet of water could be diverted from the North Platte River without interfering with senior rights. Further discussion of WyCoalGas' water rights and the operating study are provided in the Project Description Technical Report and the Hydrology and Water Quality Technical Report (WCC 1981c) which are available from the BLM, Wyoming State Office, 2515 Warren Avenue, Cheyenne, Wyoming 82001, (307) 778-2220.

Combs Reservoir. The water supply system would include a private reservoir, Combs Reservoir, to be located on Soldier Creek northwest

Surface Water Supply. Under an agreement with the Douglas Reservoirs Water Users Association, Pendmile Society contracted for up to 3,000 acre-feet of water per year (Wyoming State Board of Control Order No. 20) from the Association's Laramie Reservoir in exchange for guaranteeing a loan to finance the rehabilitation of Laramie Dam (rehabilitation was completed in 1975). Pendmile Ranches also obtained a direct flood flow right from the North Platte River with a priority date of 1974, and a storage right for this water. WyCoalGas would be able to obtain water from the river, when in priority, at a maximum rate of 201.2 cubic feet per second (cfs), not to exceed 26,579 acre-feet for storage in any year.

WyCoalGas conducted an operation study to determine the annual availability of Laramie Reservoir and North Platte River water for the proposed project. The study basically consisted of superimposing the operating criteria for the project on the North Platte River system model developed by the Water Resources Research Institute. The modeling period was 1930 through 1979. Operating criteria included those delineated in Wyoming State Board of Control Order No. 20 and water rights of senior appropriators on the North Platte River. The operating study indicated that an annual average of 5,510 acre-feet of water would be available to the project from Laramie Reservoir and 11,300 acre-feet of water could be diverted from the North Platte River without interfering with senior rights. Further discussion of WyCoalGas' water rights and the operating study are provided in the Project Description Technical Report and the Hydrology and Water Quality Technical Report (WOE 1/1810) which are available from the BLM, Wyoming State Office, 2515 Warren Avenue, Cheyenne, Wyoming 82001, (307) 778-2220.

Combs Reservoir. The water supply system would include a private reservoir, Combs Reservoir, to be located on Soldier Creek northwest

of Douglas. The major function of this reservoir would be to store water from Panhandle Eastern's 1974 North Platte River right and LaPrele Reservoir water belonging to WyCoalGas but in excess of plant needs at the time it was available.

Combs Reservoir would have a normal maximum storage capacity of 26,539 acre-feet. The dam for the reservoir would be a zoned earth embankment approximately 114 feet above the original ground surface at Soldier Creek. It would have a crest elevation of 4,976 feet and a crest length of approximately 6,500 feet. The upstream slope of the dam would have a 3:1 slope and the downstream slope would be 2.5:1. The dam would have a compacted earth cutoff excavated 10 feet into the underlying bedrock. Upstream slope protection would be provided by 30 inches of riprap on 12 inches of bedding. The downstream face of the dam would be reclaimed as outlined in Appendix A-1. An emergency spillway would be located on the right abutment of the dam, designed to handle the discharge of the Maximum Probable Flood on Soldier Creek.

During plant operation, Combs Reservoir would fluctuate with the availability of water from the North Platte River and LaPrele Reservoir. Pertinent design characteristics of the reservoir are as follows:

- Maximum reservoir elevation: 4,973.4 feet above mean sea level (MSL)
- Normal maximum reservoir elevation: 4,960 feet above MSL
- Minimum reservoir elevation: 4,880 feet above MSL
- Maximum reservoir storage: 40,155 acre-feet

of Douglas. The major function of this reservoir would be to store water from Pueblo's Eastern's 1974 North Platte River right and Laramie Reservoir water belonging to Wyoming but in excess of plant needs at the time it was available.

Combs Reservoir would have a normal maximum storage capacity of 75,320 acre-feet. The dam for the reservoir would be a zoned earth embankment approximately 115 feet above the original ground surface at Soldier Creek. It would have a crest elevation of 4,975 feet and a crest length of approximately 6,300 feet. The upstream slope of the dam would have a 3:1 slope and the downstream slope would be 2.5:1. The dam would have a compacted earth cutoff excavated 10 feet into the underlying bedrock. Upstream slope protection would be provided by 30 inches of riprap on 12 inches of bedding. The downstream face of the dam would be reclaimed as outlined in Appendix A-1. An emergency spillway would be located on the right abutment of the dam, designed to handle the discharge of the Maximum Probable Flood on Soldier Creek.

During plant operation, Combs Reservoir would fluctuate with the availability of water from the North Platte River and Laramie Reservoir. Pertinent design characteristics of the reservoir are as follows:

- Maximum reservoir elevation: 4,973.4 feet above mean sea level (MSL)
- Normal maximum reservoir elevation: 4,960 feet above MSL
- Minimum reservoir elevation: 4,880 feet above MSL
- Maximum reservoir storage: 40,135 acre-feet

- Dead pool storage: 177 acre-feet

- Dead pool area: 31.5 acres

North Platte Intake Structure. Project water from LaPrele Reservoir would be released down the natural channel of LaPrele Creek into the North Platte River. The water would be pumped from a diversion channel on the river to Combs Reservoir. The 1974 North Platte appropriation would also be pumped from this diversion channel to the reservoir.

The diversion channel and pump station would be located approximately 3,000 feet south of Combs Reservoir on the North Platte River. An artist's conception of the diversion facilities is provided in figure 1.4-20.

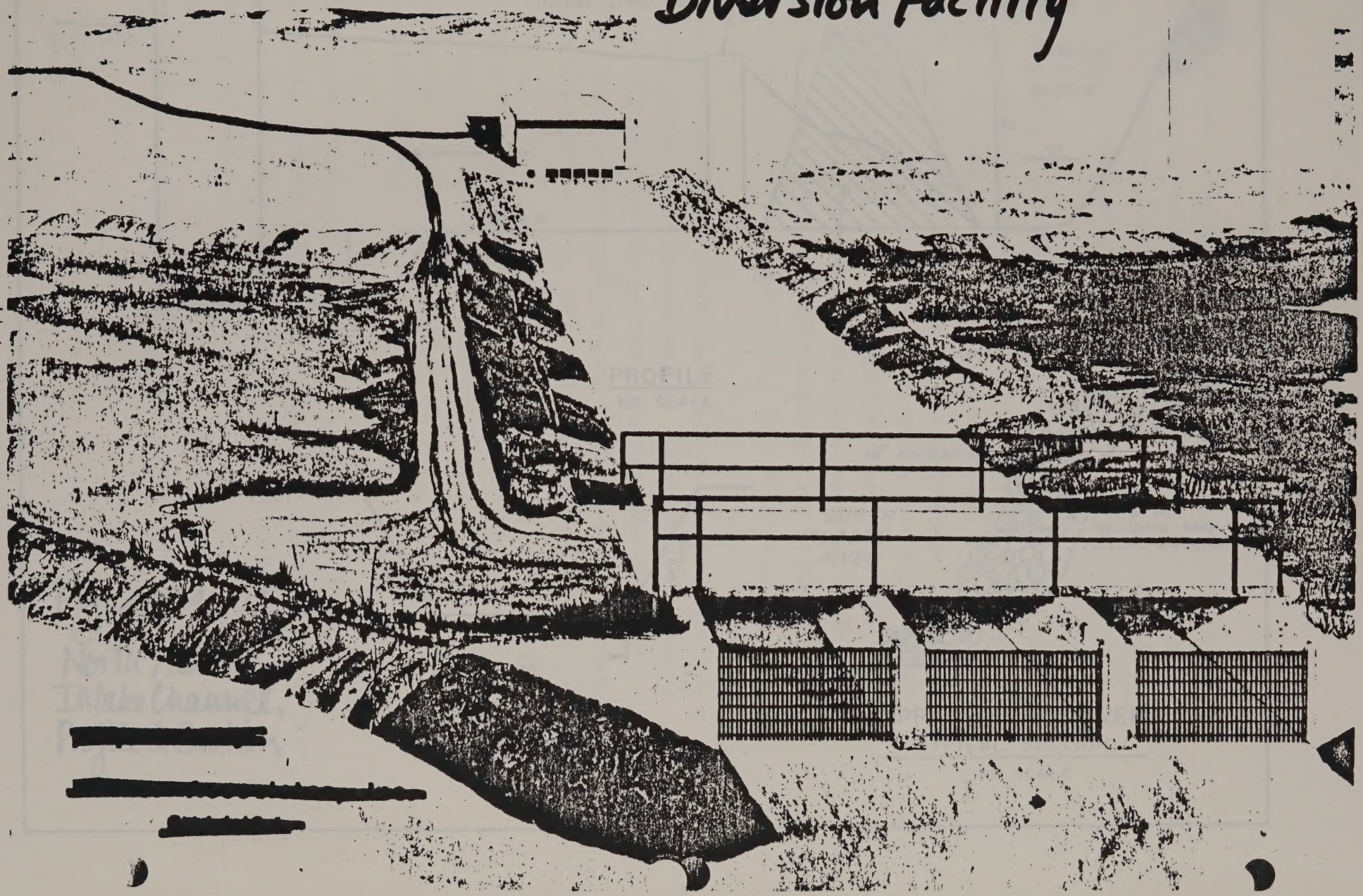
The channel would be approximately 1,000 feet long and 75 feet wide with 3:1 side slopes. It would be unlined, except for the final 200 feet before the pump station, which would be lined with riprap. The channel would intersect the North Platte River at a 45° angle away from the direction of flow. This would allow debris and sediment to move past the channel rather than being drawn into it.

The intake structure, diversion channel, pump station sump entrace, and screens have been designed so that maximum water velocity does not exceed 0.5 feet per second. Figure 1.4-21 provides a cross section and profile of the channel.

Six vertical turbine pumps, two each with capacities of 100, 50, and 25 cfs would be housed in a building at the head of the diversion channel. Design head for the pumps would be a maximum of 160 feet and

Figure 1.4-20

North Platte River Diversion Facility



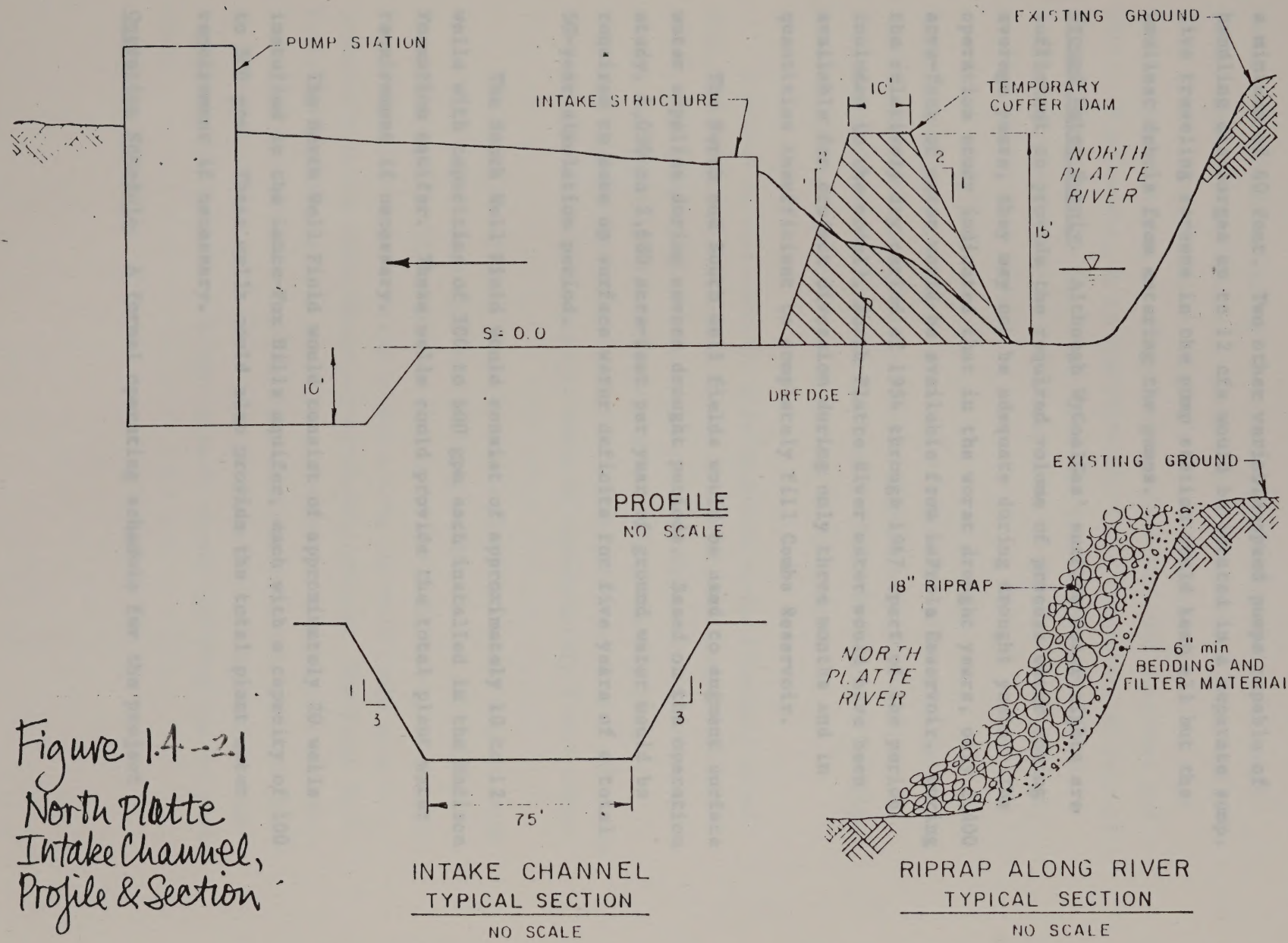


Figure 1.4-2.1
North Platte
Intake Channel,
Profile & Section

a minimum of 60 feet. Two other variable-speed pumps capable of handling discharges up to 12 cfs would be located in a separate sump. five traveling screens in the pump station would keep all but the smallest debris from entering the pumps.

Ground Water Supply. Although WyCoalGas' surface water rights are sufficient to provide the required volume of process water during average years, they may not be adequate during drought years. The operation study indicated that in the worst drought years, only 2,400 acre-feet of water would be available from LaPrele Reservoir. During the relatively dry period of 1954 through 1967 (part of the period included in the model), North Platte River water would have been available for project diversion during only three months and in quantities insufficient to completely fill Combs Reservoir.

The North and South well fields would be used to augment surface water supplies during severe drought periods. Based on the operation study, 1,050 to 2,680 acre-feet per year of ground water would be required to make up surface water deficits for five years of a total 50-year simulation period.

The South Well Field would consist of approximately 10 to 12 wells with capacities of 300 to 600 gpm each installed in the Madison Formation aquifer. These wells could provide the total plant water requirement if necessary.

The North Well Field would consist of approximately 20 wells installed in the Lance-Fox Hills aquifer, each with a capacity of 100 to 300 gpm. These wells could also provide the total plant water requirement if necessary.

Operation Schedule. A formal operating schedule for the project

a minimum of 80 feet. Two other variable-speed pumps capable of handling discharges up to 12 cfs would be located in a separate sump. Five traveling screens in the pump station would keep all but the smallest debris from entering the pumps.

Ground Water Supply. Although Wyoscidna' surface water rights are sufficient to provide the required volume of process water during average years, they may not be adequate during drought years. The operation study indicated that in dry water drought years, only 2,600 acre-feet of water would be available from Lafrels Reservoir. During the relatively dry period of 1954 through 1957 (part of the period included in the model), North Platte River water would have been available for project diversion during only three months and is quantities insufficient to completely fill Combs Reservoir.

The North and South well fields would be used to augment surface water supplies during severe drought periods. Based on the operation study, 1,030 to 2,880 acre-feet per year of ground water would be required to make up surface water deficits for five years of a total 50-year simulation period.

The South Well Field would consist of approximately 10 to 12 wells with capacities of 300 to 800 gpm each installed in the Madison Formation aquifer. These wells could provide the total plant water requirement if necessary.

The North Well Field would consist of approximately 20 wells installed in the Lance-Fox Hills aquifer, each with a capacity of 100 to 300 gpm. These wells could also provide the total plant water requirement if necessary.

Operation Schedule. A formal operating schedule for the project

water supply sources has not been developed. The choice of water sources would be as follows. North Platte River flood flows would be used first, when available. LaPrele Reservoir water would be used second, as available, to the allowed maximum of 5,000 acre-feet per year. If necessary, up to approximately 2,000 acre-feet per year of water from the South Well Field would be used next. Finally, a maximum of about 2,000 acre-feel per year of water would be pumped from the North Well Field.

Water Pipelines. A 66-inch diameter steel or concrete pipeline capable of withstanding pressures of 185 psi would transport water from the North Platte intake structure to Combs Reservoir. The pipe would be buried approximately five feet below ground.

A buried 24-inch diameter steel pipeline would transport water from Combs Reservoir 14 miles to the raw water storage pond at the plant. Two pumping stations, one near Combs Reservoir (650-horsepower pumps) and the other approximately midway along the pipeline (550-horsepower pumps) would maintain normal flows of 9 cfs. The area occupied by each pumping station would be approximately 3 to 5 acres.

Buried 6- to 10-inch diameter steel pipelines would connect each water well to a buried main collection pipeline in the well fields. The South Well Field collection line would be 18 inches in diameter. It would extend approximately 14 miles from the well field to a junction with the Combs Reservoir-to-plant pipeline. The North Well Field collection pipeline would be 14 inches in diameter and extend 5.9 miles from the field to the raw water storage pond. Maximum flow in both lines would be 9 cfs. Booster pumps may be required at some well sites to provide sufficient head to convey the water to the plant site.

A list of the stream crossings for the water pipelines is provided in Appendix A-2.

Construction Procedures. The reservoir and dam areas would be cleared of all trees. Topsoil from the dam site would be stripped and stored for reclamation. Following clearing and grubbing of the excavation area and grouting of a segment of the foundation, embankment construction would begin. Portions of the reservoir site would be excavated to provide material for the embankment. Fugitive dust generated during construction would be controlled by periodic application of water to haul roads, borrow pits, embankment construction areas, and other areas with the potential to generate dust.

Riprap for the downstream face of the reservoir dam would be hauled from sites west of Douglas or from a quarry near Guernsey.

Overburden soils in the vicinity of the spillways would be excavated with conventional heavy earth-moving equipment. Excavation of the bedrock at the spillways would probably require the use of a large tractor equipped with a single-tooth hydraulic ripper. Table 1.4-15 lists major equipment required for reservoir construction.

Construction of the diversion channel would begin with excavation of all but the last 50 feet adjacent to the river. This unexcavated portion of the channel would serve as a dam during construction of the intake structure and pump station. After these facilities have been completed, a cofferdam would be built in the river to allow completion of the diversion channel. Riprap would be placed on the sides and bottom of the diversion channel upstream of the gate structure and on the bank of the river 50 feet above and below the channel. The cofferdam would then be removed and the bottom of the river would be

A list of the stream crossings for the water pipelines is provided in Appendix A-2.

Construction Procedure. The reservoir and dam areas would be cleared of all trees. Topsoil from the dam site would be stripped and stored for reclamation. Following clearing and grubbing of the excavation area and grouting at a segment of the foundation, embankment construction would begin. Portions of the reservoir site would be excavated to provide material for the embankment. Fugitive dust generated during construction would be controlled by periodic application of water on haul roads, borrow pits, embankment construction areas, and other areas with the potential to generate dust.

Riprap for the downstream face of the reservoir dam would be hauled from sites west of Tongue or from a quarry near Sunnyway.

Construction noise in the vicinity of the spillway would be excessive with conventional heavy earth-moving equipment. Excavation of the bedrock at the spillway would probably require the use of a large tracker equipped with a single-tooth hydraulic ripper. Table I.4-15 lists major equipment required for reservoir construction.

Construction of the diversion channel would begin with excavation of all but the last 50 feet adjacent to the river. This unexcavated portion of the channel would serve as a dam during construction of the intake structure and pump station. After these facilities have been completed, a cofferdam would be built in the river to allow completion of the diversion channel. Riprap would be placed on the sides and bottom of the diversion channel upstream of the gate structure and on the bank of the river 30 feet above and below the channel. The cofferdam would then be removed and the bottom of the river would be

TABLE 1.4-15

EQUIPMENT REQUIRED FOR RESERVOIR CONSTRUCTION

Item	Number
Concrete Batch Plant	1
Aggregate Screening Plant	1
Cranes	4
Trucks	18
Light Plants	10
Scrapers	20
Push Cats	2
Dozers with Ripper	4
Compacters	3
Industrial Disc	2
Waterwagons	2
Patrols	3
Backhoe	1
Dragline	1
Loaders	4
Drilling Rig	2
Grout Pump	2
Concrete Pump	1

TABLE 1.4-15a

EQUIPMENT REQUIRED FOR PIPELINE CONSTRUCTION

Item	Number
Backhoe	2
Loaders	2
Patrol	1
Dozer with Ripper	1
Trucks	8
Crane	1
Compaction Equipment	1
Pumps	4
Boring Equipment	1
Farm Tractor and Spreader	1

dredged to allow low river flows to enter the channel.

After construction of access roads into the well fields, a drill pad would be installed at each well site (Figure 1.4-22). Approximately 2.5 acres would be cleared and leveled at each well site in a manner that would minimize cut-and-fill and the alteration of natural drainage courses. A 40,000-barrel-capacity mud pit would be located on each drill pad.

Standard drilling procedures would be employed for well installation. A 17-inch diameter hole would be drilled and cased to a depth of 100 feet. A 12-inch diameter hole would then be drilled and cased to a depth of 1,800 feet. After this, an 8.75-inch hole would be drilled and cased to the top of the formation. The casings would be cemented to prevent cross contamination between aquifers.

Drilling fluids would be discharged into the mud pit to evaporate. Before drilling into the producing formation, the mud in the well hole would be replaced with clear water.

Following well completion and removal of the rig, the well site would be reclaimed as outlined in Appendix A-1. Completed wells would occupy about 0.5 acre.

After an estimate of the well yield has been made, the well would be tested for volume output, water quality, and drawdown before installation of a permanent pump. If necessary, a stimulation treatment involving an acid-fracture process would be undertaken to increase productivity.

A dragline or backhoe would be used to excavate the trench for the 66-inch pipeline running from the pump station to Combs Reservoir.

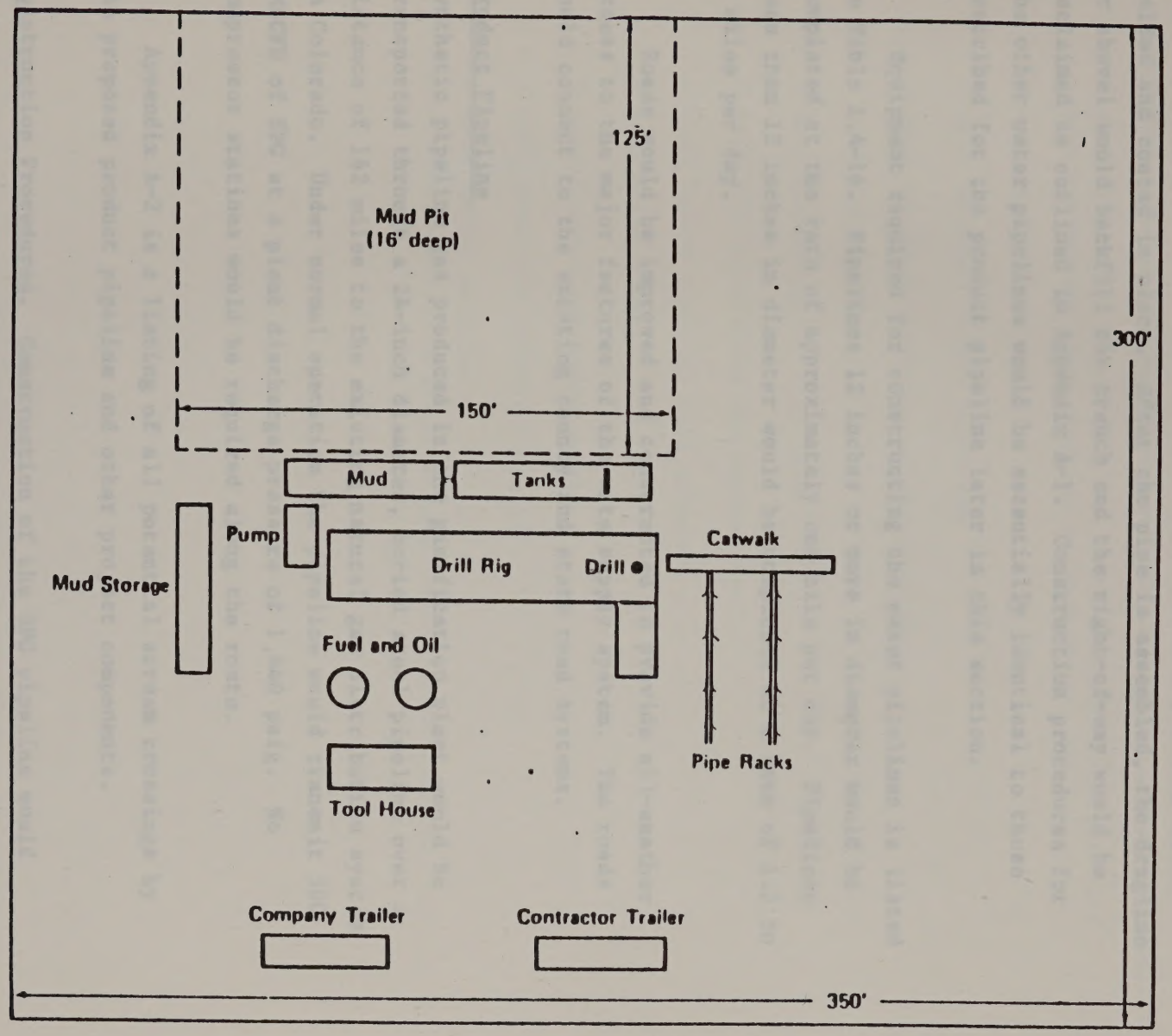


Figure WELL FACILITY DRILLING CONFIGURATION

1-69

1.4-22

Segments of pipe would be lowered into the trench separately and welded and coated in place. After the pipe is assembled, the dragline or shovel would backfill the trench and the right-of-way would be reclaimed as outlined in Appendix A-1. Construction procedures for the other water pipelines would be essentially identical to those described for the product pipeline later in this section.

Equipment required for constructing the water pipelines is listed in Table 1.4-16. Pipelines 12 inches or more in diameter would be completed at the rate of approximately one mile per day. Pipelines less than 12 inches in diameter would be completed at a rate of 1.5 to 2 miles per day.

Roads would be improved and constructed to provide all-weather access to the major features of the wate supply system. The roads would connect to the existing county and state road systems.

Product Pipeline

Synthetic pipeline gas produced in the gasification plant would be transported through a 24-inch diameter, buried steel pipeline over a distance of 162 miles to the existing natural gas distribution system in Colorado. Under normal operation the pipeline would transmit 300 MMSCFD of SPG at a plant discharge pressure of 1,440 psig. No compressor stations would be required along the route.

Appendix A-2 is a listing of all potential stream crossings by the proposed product pipeline and other project components.

Construction Procedures. Construction of the SPG pipeline would disturb, at most, approximately 1,960 acres of land, assuming a 100-foot corridor. The work would take approximately 18 weeks, using two spreads.

TABLE 1.4-16

PRODUCT PIPELINE CONSTRUCTION EQUIPMENT IN A TYPICAL SPREAD

16 each 3/4 ton pick-ups or 1 ton trucks mounted with gasoline powered welding rigs, cutting torch bottles, etc.
8 each sidebooms - Cat. 572
5 each backhoes - John Deere 690
2 each ditching machines - Cleveland 340
4 each bulldozers - Cat. D-7
2 each maintainers - Cat. 14-E
7 each 3/4 ton pickups for supervisors
2 each lowboy trailers with tractors
2 each winch trucks
8 each flatbed stringing trucks
2 each buses for hauling laborers
2 each boring machines

The proposed final route design would be determined after a field survey of the centerline of the alignment; adjustments arising from this survey would not exceed approximately 1/4 mile. Existing roads would be used as much as possible by onground crews doing the survey, and no vegetation would be removed unless necessary to allow for the operation of surveying instruments. Survey crews would also plot topographic features that would affect pipeline construction. Additional information would be required on some features encountered to ensure construction of safe structures; for example, to ensure that river crossings are properly designed, flow volume, water use, and maximum scour depths would have to be determined.

Typically, pipelines are laid in a continuous operation by a "spread" consisting of equipment and crews handling various types of construction activities for a given pipeline segment. The following is a list of major activities, in order of occurrence:

- Clearing and grading of site
- Trenching for pipeline
- Stringing, lining, welding, and radiographic examination of pipe
- Coating and wrapping of pipe
- Lowering in pipe
- Backfilling trench
- Hydrostatic testing of pipeline
- Tie-in of pipeline to existing system
- Cleanup and revegetation of site

Each of these operations is described below. Figures 1.4-23 and 1.4-24 show components of a typical spread. Table 1.4-16 lists major pieces of equipment that would be used on a main pipeline spread;

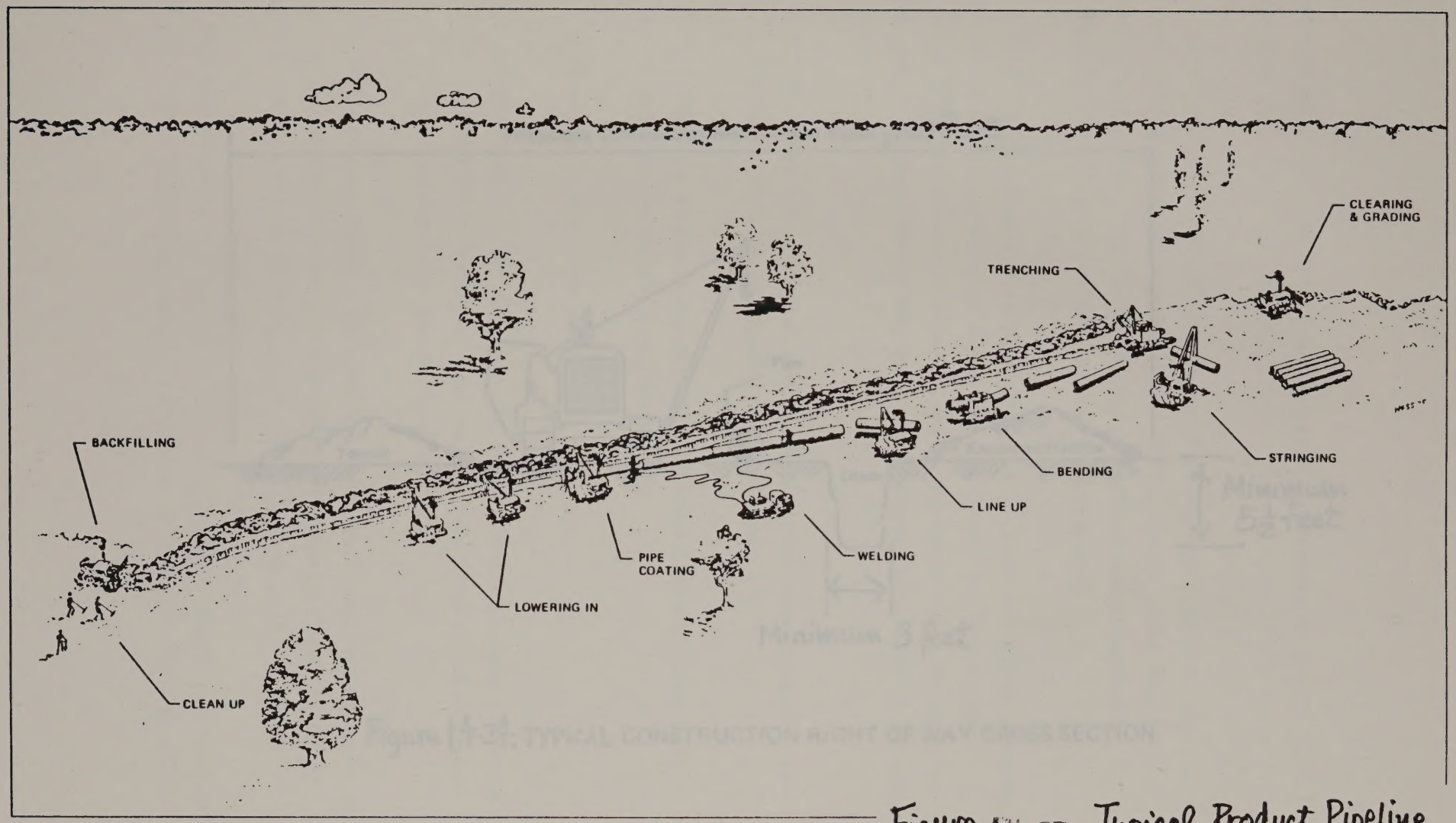


Figure 1.4-23 Typical Product Pipeline Construction Spread

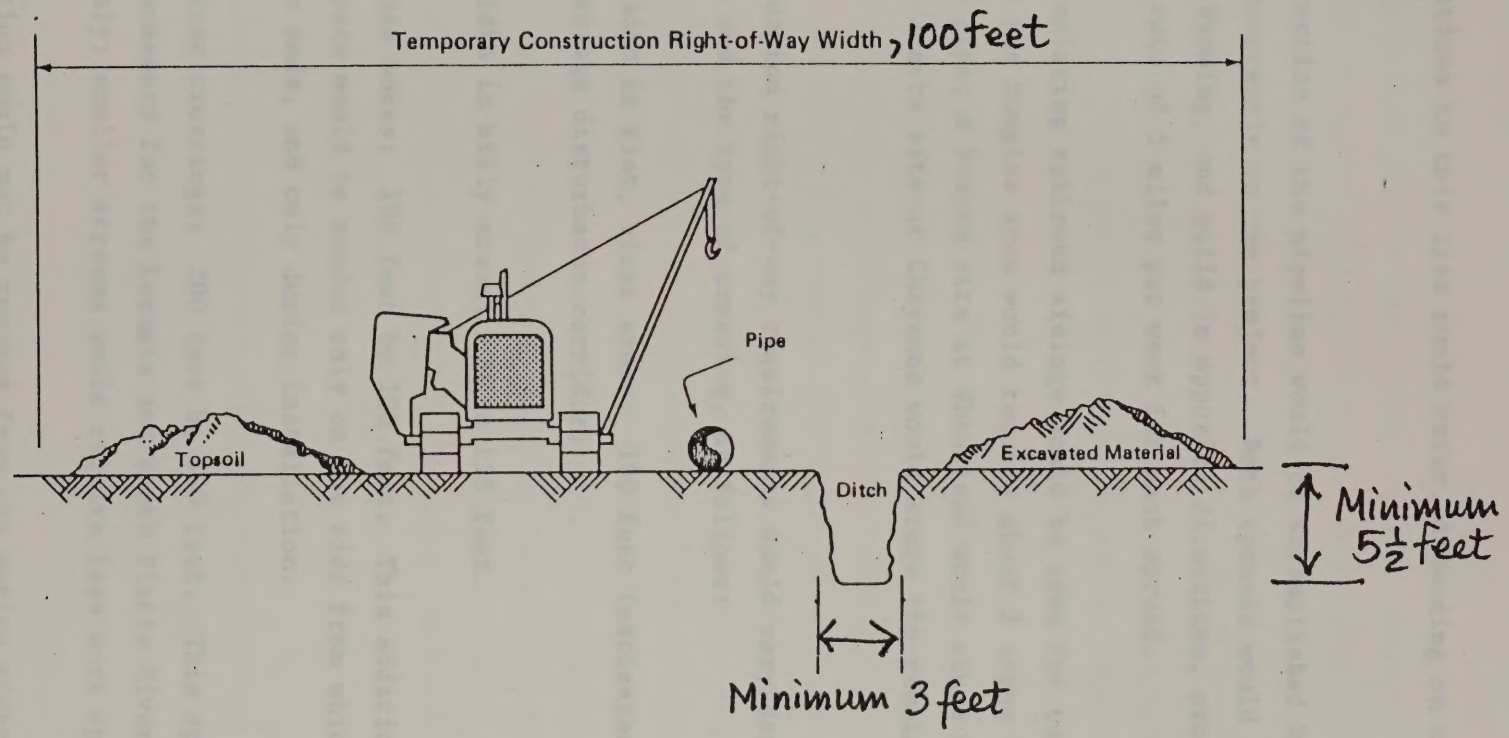


Figure 1.4-24: TYPICAL CONSTRUCTION RIGHT-OF-WAY CROSS SECTION

minor variations to this list could occur, depending on contractors selected.

Construction of the pipeline would be accomplished by two crews working concurrently on the project. Both spreads would begin at Wheatland, Wyoming, and build in opposite directions, proceeding at an average rate of 5 miles per week for each spread.

Three existing railroad sidings would be used for receiving pipe. A siding in the Douglas area would require about 3 acres to store 40 miles of pipe; a 5-acre site at Wheatland would store 82 miles of pipe; and a 3-acre site at Cheyenne would store the remaining 40 miles of pipe.

Construction right-of-way requirements would vary depending on the terrain and the type of crossing, as follows:

- Width in flat, clear areas: 100 feet (estimated 66 foot average disturbance corridor).
- Width in hilly areas: 100 to 125 feet.
- Road bores: 100 feet by 300 feet. This additional working space would be needed only on the side from which the bore is made, and only during installation.
- River crossings: 200 feet by 300 feet. This space would be necessary for the Laramie and North Platte River crossings only; smaller streams would require less work space.

Vegetation would not be removed from the entire right-of-way, but only from those areas where it is necessary to provide safe and effi-

cient operation of construction equipment. The degree of vegetation clearing depends in part on the vegetation type present, but clearing would not extend beyond the right-of-way. Vegetation would be cleared from the 3-foot trench line, the storage area for excavated material, and the area required for vehicle travel and work space, and piled along the edge of the right-of-way. Soil disturbance would be small except in the pipe ditch, and root systems would be left intact. Trees growing in the right-of-way would be removed only as required for operation of construction equipment.

In remote areas where there are no access roads, the right-of-way itself would be the primary access for pipeline construction. To this end, temporary bridges or culverts would be constructed across creeks and arroyos on the working side of the right-of-way, when warranted, and where permitted by the federal surface management agency or the landowner. Where material would have to be cut away, the removed material would be used to fill in depressions and small valleys. Additional materials for approaches and fill would be obtained from the right-of-way, outside commercial sources, or adjacent lands, where permitted by the federal surface management agency or the landowner. In steep terrain where the right-of-way would have to be graded at two elevations, or in wet areas where diversion dams would be needed, the areas would upon completion of construction be contoured to resemble the original grade.

Where fences are encountered along the right-of-way, bracing would be installed at each edge of the right-of-way, fence wires would be cut, and a temporary gate would be constructed that could serve, at the landowner's discretion, as a permanent fence section upon completion of construction.

Once the right-of-way was prepared, ditching operations would

clear operation of construction equipment. The degree of vegetation clearing needed is part on the vegetation type present, but clearing would not extend beyond the right-of-way. Vegetation would be cleared from the 3-foot transmission line, the storage area for excavated material, and the area required for vehicle travel and work space, and piled along the edge of the right-of-way. Soil disturbance would be small except in the pipe ditch, and root systems would be left intact. Trees growing in the right-of-way would be removed only as required for operation of construction equipment.

In remote areas where there are no access roads, the right-of-way itself would be the primary access for pipeline construction. To this end, temporary bridges or culverts would be constructed across creeks and arroyos on the working side of the right-of-way, when warranted, and where permitted by the federal surface management agency or the landowner. Where material would have to be cut away, the removed material would be used to fill in depressions and small valleys. Additional materials for approaches and fill would be obtained from the right-of-way, outside commercial sources, or adjacent lands, where permitted by the federal surface management agency or the landowner. In steep terrain where the right-of-way would have to be graded at two elevations, or in wet areas where diversion dams would be needed, the areas would upon completion of construction be restored to resemble the original grade.

Where fences are encountered along the right-of-way, bracing would be installed at each edge of the right-of-way, fence wires would be cut, and a temporary gate would be constructed that could serve, at the landowner's discretion, as a permanent fence section upon completion of construction.

Once the right-of-way was prepared, ditching operations would

begin. Most of the ditch would be excavated mechanically with ditching machines, backhoes, draglines, and cranes with clamshell buckets. Hand digging would be used to locate buried utilities, such as pipelines and cables. Generally, ditching operations would use ditching machines in open areas and backhoes near rivers and in tight areas; in areas of loose or unconsolidated rock, the ditch line would be ripped mechanically.

If the material encountered could not be ripped, it would be blasted. Unconsolidated material would be removed from the ditch-line end and a series of holes would be drilled by air-powered drills, typically suspended from a side-boom tractor. If blasting is necessary, the following safety precautions would be taken:

- In areas of human use, shots would be blanketed (matted).
- Landowners or tenants in close proximity to the shot would be notified in advance so that livestock and other property could be adequately protected.
- Before detonation, a clearance would be made to ensure that construction personnel, equipment, and local residents are in no danger.

Topsoil would be saved, subject to agreements with landowners and the surface management agency, and cast to the working side of the right-of-way. Ditch spoil would be cast to the opposite side so that the two soils do not mix. Upon completion of construction, the ditch would be backfilled, with the topsoil going in last.

Ditch depth would vary with the conditions encountered. The cover from the top of the pipe to ground level would be a minimum of

begin. Most of the ditch would be excavated mechanically with ditching machines, backhoes, draglines, and cranes with clamshell buckets. Hand digging would be used to locate buried utilities, such as pipelines and cables. Generally, ditching operations would use ditching machines in open areas and backhoes near rivers and in tight areas; in areas of loose or unconsolidated rock, the ditch line would be ripped mechanically.

If the material encountered could not be ripped, it would be blasted. Unconsolidated material would be removed from the ditch-line and and a series of holes would be drilled by air-powered drills, typically transported from a side-boom tractor. If blasting is necessary, the following safety precautions would be taken:

- In areas of human use, shots would be blanketed (muffled).

- Landowners or tenants in close proximity to the shot would be notified in advance so that livestock and other property would be adequately protected.

- Before detonation, a clearance would be made to ensure that construction personnel, equipment, and local residents are in no danger.

Topsoil would be saved, subject to agreements with landowners and the surface management agency, and used to the working side of the right-of-way. Ditch spoil would be cast to the opposite side as the two sails do not mix. Upon completion of construction, the ditch would be backfilled, with the topsoil going in last.

Ditch depth would vary with the conditions encountered. The cover from the top of the pipe to ground level would be a minimum of

42 inches. In traversing lands where there are known plans to level the land for irrigation or other purposes, the pipeline would be buried at a depth that would permit the land to be leveled and still provide ample cover. Where the pipeline would cross canals, burrow ditches, or irrigation ditches that are dredged to maintain depth, the ditch would be deep enough to permit safe dredging operations.

Ditching operations would be timed to minimize open-ditch conditions. Where an open ditch would cross range-animal paths, driveways, or rural roads, temporary crossings such as plank bridges or unexcavated ditch line would be provided for safe and unimpeded passage.

At river crossings, the proposed pipeline would be buried in a trench. Vegetation would be cleared on each bank of the river only as necessary to provide sufficient room for work space and equipment storage. Stream crossings would be made during periods of low flow whenever possible. Banks would be reclaimed to their original profile whenever possible and would be stabilized and vegetated as outlined in Appendix A-1.

Ditches at river crossings would be deep enough that high water would not affect the pipe through scour action. The sag bends on either side of the river would be far enough from the river bank to ensure that water erosion would not expose them. Stream gradient would be maintained by removing all spoil from the bed upon completion of construction. Sand-cement sacks, breakers, or riprap would be placed over the pipeline where necessary. The pipeline would be weighted where it is underwater, to ensure that it remains in the ditch.

Generally, roadbeds supporting paved roadways or railroad tracks would be crossed by boring a hole beneath the bed rather than by

ditching across the surface. The cutting head (bit) of the auger would be slightly larger than the casing pipe or line pipe, and the pipe would advance as the auger advances. Casing would be installed at all crossings where required by federal, state, or local authorities or by the railroad owner.

Pipe welding would be conducted in accordance with Department of Transportation Regulation 192.221. All completed welds would be visually inspected before the application of pipe coating. The frequency of radiographic inspection would meet or exceed Department of Transportation Regulation 192.243. For sections of pipe to be placed beneath railroads, highway rights-of-way, and rivers, all welds would be radiographically inspected before installation.

The pipe would be coated, wrapped as necessary, and lowered into the ditch. Backfilling, using the excavated material, would be done so as to ensure that the space below and beside the pipe is completely filled. Backfill material that could not be placed in the ditch would be crowned on top of the ditch to compensate for future settling. Salvaged topsoil would be moved to the top of the ditch line. Once the ditch was backfilled, the right-of-way and other affected areas would be cleaned up-graded, reclaimed, and fences repaired.

Cathodic protection rectifiers would be mounted on poles adjacent to the right-of-way, with the associated anodes buried with test leads exposed at the surface. Exact locations of cathodic protection devices would be determined after the pipeline is installed and tested.

The entire pipeline would be hydrostatically tested in accordance with CFR 192, "Subpart J, Test Requirements." Test water would be obtained from rivers, creeks, or privately owned irrigation wells or canals, through agreements negotiated with local authorities control-

ditching across the surface. The cutting head (bit) of the auger would be slightly larger than the casing pipe or line pipe, and the pipe would advance as the auger advances. Casing would be installed at all crossings where required by federal, state, or local authorities or by the railroad owner.

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The entire pipeline would be hydrostatically tested in accordance with CFR 192, "Subpart J, Test Requirements." Test water would be obtained from rivers, creeks, or privately owned irrigation wells or canals, through agreements negotiated with local authorities control-

ling the water resources. Test water would be reused in successive pipeline segments, and would be released in accordance with federal, state, and local agency requirements governing discharge points, release rates, and water quality. Based on two spreads, each approximately 20 miles long, and assuming reuse of test water in successive spreads, the estimated maximum amount of water that would be required for testing is 15 acre-feet; the precise amount depends on the chosen testing procedures.

Operation and Maintenance. A work force of six people would operate the pipeline. The staff would consist of an area foreman, a measurement technician, two fieldmen and two repairmen, based in Douglas.

The right-of-way would be inspected approximately once a week by an aerial patrol. Valves and other above-ground facilities would be located next to roadways so that off-road traffic would be limited to emergency repairs on the pipeline or erosion-control devices. Corridor maintenance would be required only to prevent growth of trees over the line. Because of the current vegetative composition of the selected route it appears that little maintenance would be necessary.

Railroad

The electrically-powered single-track main line railroad, would extend approximately 40 miles from a rail spur at the Rochelle Mine to the plant site. Pertinent design parameters for the railroad are listed in Table 1.4-17.

Three passing sidings approximately 2 miles in total length, and several minor sidings along the line would handle disabled railcars. A 16-foot wide limited-access maintenance road would parallel the railroad; this road would not be used as a means of public or work

line the water resources. That water would be routed in successive pipeline segments, and would be released in accordance with federal, state, and local agency requirements governing discharge points, release rates, and water quality. Based on two spreads, each approximately 10 miles long, and assuming rates of test water in successive spreads, the estimated maximum amount of water that would be required for testing is 15 acre-feet; the precise amount depends on the chosen testing procedures.

Operation and Maintenance. A work force of six people would operate the pipeline. The staff would consist of an area foreman, a measurement technician, two fieldmen and two repairmen, based in Douglas.

The right-of-way would be inspected approximately once a week by an aerial patrol. Valves and other above-ground facilities would be located next to roadways so that off-road traffic would be limited to emergency repairs on the pipeline or remote-control devices. Corridor maintenance would be required only to prevent growth of trees over the line. Because of the current vegetative composition of the selected route it appears that little maintenance would be necessary.

Railroad

The electrically-powered single-track main line railroad, would extend approximately 40 miles from a rail spur at the Rochelle Mine to the plant site. Preliminary design parameters for the railroad are listed in Table 1.4-17.

Trains passing siding approximately 3 miles in total length, and several other sidings along the line would handle disabled railcars. A 16-foot wide limited-access maintenance road would parallel the railroad; this road would not be used as a means of public or work

TABLE 1.4-17

RAILROAD CHARACTERISTICS

Length of Alignment	40 miles
Length of Rails	425,000 feet
Total Excavation	4,000,000 yards
Maximum Grade	1 percent
Maximum Curve	6 percent
Maximum Height of Fill	120 feet
Maximum Depth of Cuts	60 feet
Number of Bridges	2

TABLE I.4-17

RAILROAD CHARACTERISTICS

Length of Alignment	40 miles
Length of Rail	425,000 feet
Total Excavation	4,000,000 yards
Maximum Grade	1 percent
Maximum Curve	6 percent
Maximum Height of Fill	120 feet
Maximum Depth of Cuts	60 feet
Number of Bridges	2

force transportation.

The proposed railroad right-of-way would have approximately 16 crossings of unimproved and graded dirt roads, all lightly used for access to ranches and oil fields. Crossings at private and public roads would be designed to maximize safety to vehicular traffic, and would be either grade crossings with warning signs, grade crossings with signals and automatic gates, or separated grade crossings. Each crossing would conform to county and/or state requirements for public roads and to agreements negotiated with landowners for private roads. Numerous stock crossings would be provided, in the form of large culverts, underpasses, or separated grade crossings; types of crossings would depend on topography, frequency of use, and the existence of other crossing facilities on the adjacent highway.

Culverts would be installed at all stream crossings. Appendix A-2 is a listing of all stream crossings by the proposed railroad and other project components.

The railroad would use electric locomotives for primary power, with diesel or diesel-electric units for maintenance, emergencies, and possible switching needs at the plant and mine. Because of the peak single-phase load requirements for the system, operational power would be purchased from the local utility, rather than generated at the plant site. A substation, less than 1/4 acre in area, would be constructed alongside the utility's proposed substation to convert 3-phase power at 230 kV to 50-kV single-phase power. This would be transmitted by an overhead conductor line from the substation on the west side of State Highway 59, approximately 800 feet to the railroad, adjacent to the east side of the highway.

Power would be distributed to the locomotives through a catenary

force transportation.

The proposed railroad right-of-way would have approximately 16 crossings of undeveloped and graded dirt roads, all highly used for access to ranches and oil fields. Crossings at private and public roads would be designed to maximize safety to vehicular traffic, and would be either grade crossings with warning signs, grade crossings with signals and automatic gates, or separated grade crossings. Each crossing would conform to county and/or state requirements for public roads and to agreements negotiated with landowners for private roads. Numerous stock crossings would be provided, in the form of large culverts, underpasses, or separated grade crossings; types of crossings would depend on topography, frequency of use, and the existence of other crossing facilities on the adjacent highway.

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Power would be distributed to the locomotives through a catenary

suspended over the rails. Figures 1.4-25 and 1.4-26 are typical cross-section and side elevation showing the roadbed, subballast, ballast, ties, rail, and power supply. The catenary support structure would include insulating parts and perches designed to avoid electrocution of birds landing on the structure. The electric circuit would be completed using the rails and a return conducter. These would be grounded so that the rails could not become energized and pose a risk of electrocution to animals or humans. Two physical barriers would be placed at each road crossing to guarantee vehicular clearance of the power line.

Typical railroad configuration would have a subgrade width of 25 feet at the top of the fill sections and the bottom of cut sections. A 12-inch deep, 25-foot wide layer of subballast would be compacted on top of the subgrade; a total of 115,000 cubic yards of material would be required for the entire length. Material for ballast and subballast would come from scoria deposits located along the right-of-way and at the Rochelle Mine. The primary ballast would consist of a 14-inch layer of crushed rock, 8 inches deep below the ties and 6 inches deep between the ties. The 6-inch by 8-inch ties would be made of treated wood, and rails would be continuously welded for stability, quietness, and reduced maintenance cost.

Switch protection would be provided at the sidings as required and at interfaces with the plant site and mine site. Track signaling systems would be designed to accommodate the buildup of train operations through full plant operation, with few changes and without interrupting train movement.

A voice communication system would be provided among trains, and to a central supervisory post at the gasification plant. Communications would also be provided between specific points along the rail

unpeopled over the rails. Figures 1.4-25 and 1.4-26 are typical cross-sections and side elevations showing the roadbed, subballast, ballast, ties, rail, and power supply. The necessary support structure would include insulating parts and parts designed to avoid electrocution of birds landing on the structure. The electric circuit would be semi-placed using the rails and a return conductor. These would be grounded so that the rails could not become energized and pose a risk of electrocution to animals or humans. Two physical barriers would be placed at each road crossing to guarantee vehicular clearance of the power line.

Typical railroad reconfiguration would have a subgrade width of 25 feet at the top of the fill sections and the bottom of cut sections. A 12-inch deep, 25-foot wide layer of subballast would be compacted on top of the subgrade; a total of 113,000 cubic yards of material would be required for the entire length. Material for ballast and subballast would come from rocks deposits located along the right-of-way and at the Goodale mine. The primary ballast would consist of a 14-inch layer of crushed rock, 8 inches deep below the ties and 6 inches deep between the ties. The 8-inch by 8-inch ties would be made of treated wood, and rails would be continuously welded for stability, quietness, and reduced maintenance cost.

Switch protection would be provided at the siding as required and at interfaces with the plant site and mine site. Track signaling system would be designed to accommodate the holding of train operations through full plant operation, with few changes and without interrupting train movement.

A voice communication system would be provided among trains, and to a central supervisory post at the pelletization plant. Communications would also be provided between specific points along the rail

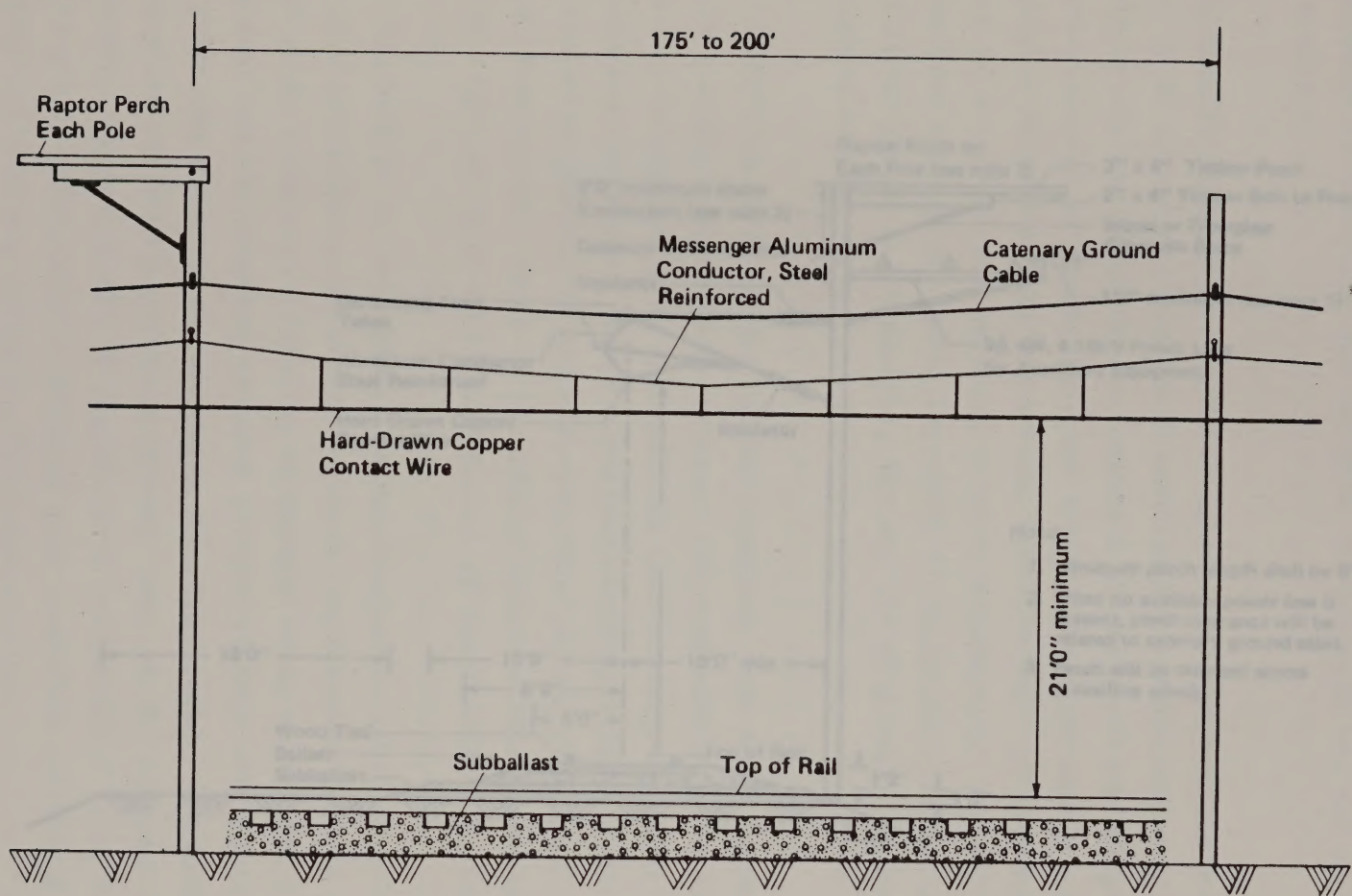
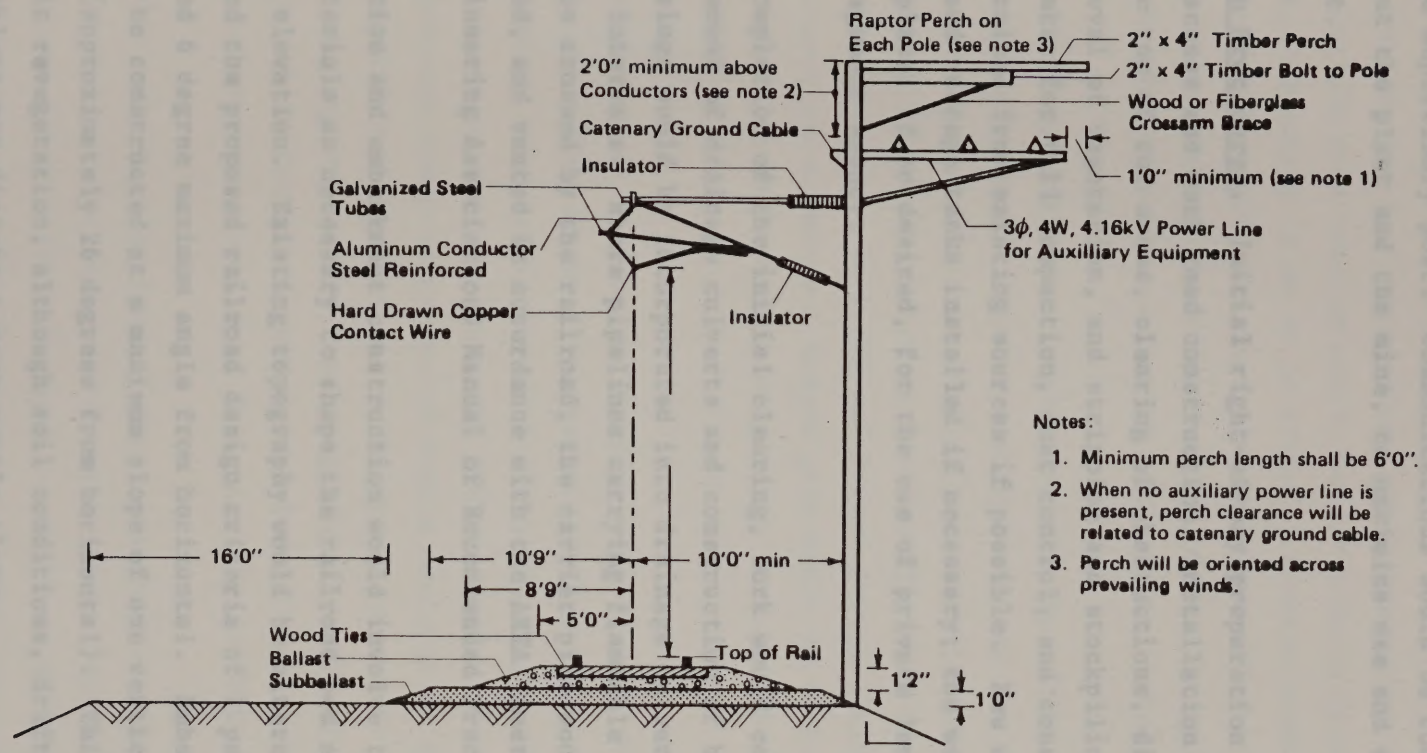


Figure ~~3.5-3~~ 1.4-25
TYPICAL SIDE ELEVATION



Notes:

1. Minimum perch length shall be 6'0".
2. When no auxiliary power line is present, perch clearance will be related to catenary ground cable.
3. Perch will be oriented across prevailing winds.

Figure ~~3.5-2~~ 1.4-26
TYPICAL CROSS SECTION OF RAILROAD

line and the supervisory post. Communications would be coordinated with those at the plant and the mine, to maximize use and uniformity of equipment.

Construction Procedures. Initial right-of-way preparation would consist of access and work road construction, installation of work roads to the top of cut areas, clearing of obstructions, disposal of debris, removal of vegetation, and stripping and stockpiling of topsoil. Water for fill compaction, dust control, and consumption would be obtained from existing sources if possible. New wells would be drilled and storage tanks installed if necessary; the wells would be left in place, if so desired, for the use of private landowners or surface management agency.

Upon completion of the initial clearing, work would commence on the placement of drainage culverts and construction of bridges. Cattle crossings would be incorporated into drainage culverts at appropriate intervals. Where pipelines carrying flammable gas or oil are to be crossed by the railroad, the carrier pipe would be cased, sealed, and vented in accordance with the AREA (American Railway Engineering Association) Manual of Recommended Practice.

Excavation and embankment construction would involve the movement of earth materials as necessary to shape the railroad bed and obtain final grade elevation. Existing topography would be altered to meet alignment and the proposed railroad design criteria of 1 percent maximum grade and 6 degree maximum angle from horizontal. Embankment sides would be constructed at a maximum slope of one vertical to two horizontal (approximately 26 degrees from horizontal). This is expected to permit revegetation, although soil conditions, drifting snow, or other problems may dictate a more gentle slope.

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All suitable excavated materials would be stored and used as fill to form the embankments for the roadbed. Fill operations would place excavated materials from cuts or nearby borrow pits in layers 8 to 10 inches thick, compacting it as it is placed. A water truck would wet the fill materials for maximum compaction. A 90 to 95 percent compaction density is desired on the roadbed fill; compaction would be monitored by performing standard compaction tests on collected samples.

If insufficient material is available from excavation areas, it would be necessary to obtain special use permits from the appropriate surface management agency to mine available areas adjacent to the rail line. Operations in borrow pit areas would comply with regulations of the Wyoming Mine Land Act, with BLM and Forest Service stipulations, and with contract requirements. Borrow pits would be shaped to conform to the natural surroundings, revegetated, and provided with drainage facilities.

Upon completion of grading and shaping, the roadway would be surfaced with subballast material excavated, with surface management agency permission, from scoria deposits along the route; trucked to a rock crusher and screening plant; and hauled to the completed railroad bed. Although the primary use of scoria would be as subballast, ancillary facilities such as access roads, grade crossings, underpasses, and staging areas would require gravel for surfacing. The total project demand for scoria and gravel for all uses associated with railroad construction would be approximately 160,000 cubic yards.

Following subballast placement, the track, welded into 2,000-foot sections at the plant site and transported to the construction area, would be laid and final welds made, and the final or primary ballast, consisting of crushed rock from local sources, would be installed and tamped.

All suitable excavated materials would be stored and used as fill to form the embankments for the roadbed. Fill operations would place excavated materials from cuts or nearby borrow pits in layers 8 to 10 inches thick, compacting it as it is placed. A water truck would wet the fill materials for maximum compaction. A 90 to 95 percent compaction density is desired on the roadbed fill; compaction would be monitored by performing standard compaction tests on collected samples.

If insufficient material is available from excavation areas, it would be necessary to obtain granular sub pavements from the appropriate surface management agency to mine available areas adjacent to the rail line. Operations in borrow pit areas would comply with regulations of the Wyoming Mine Land Act, with BLM and Forest Service stipulations, and with contract requirements. Borrow pits would be shaped to conform to the natural surroundings, revegetated, and provided with drainage facilities.

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Following subballast placement, the track, welded into 2,000-foot sections at the plant site and transported to the construction area, would be laid and final ballast, and the final or primary ballast, consisting of crushed rock from local sources, would be installed and tamped.

Typical cut and fill sections are shown in Figure 1.4-27. Typical road crossing configurations and culvert designs are illustrated in Figures 1.4-28 and 1.4-29, respectively.

Railroad Operations. Coal handling would become the responsibility of WyCoalGas, Inc., as soon as the coal was loaded into railcars at the mine. Four identical unit trains, each with two electric locomotive units and thirty-one 100-ton capacity bottom-dump railcars, would be used to haul the coal. A single unit train would therefore carry 3,100 tons of coal. Train units would be kept together, and used solely for transporting coal between the mine and the plant. During periods when ambient temperature was above freezing, thus allowing the wet process ash to be easily handled, the ash would be returned by train to be buried at the mine during the reclamation process; ash would be transported in separate rail cars designated for this purpose.

A unit train would be approximately 1,900 feet long. Trains would operate at an average speed of 35 miles per hour, passing a given point in approximately 40 seconds. The proposed rail line would have three passing sidings at roughly equal intervals along the route. A train would be dispatched every 2 hours from the mine. Four trains working on an 8-hour cycle (i.e., three trips per day), 6 days per week, 50 weeks per year would transport 11,160,000 tons per year of coal to the gasification plant.

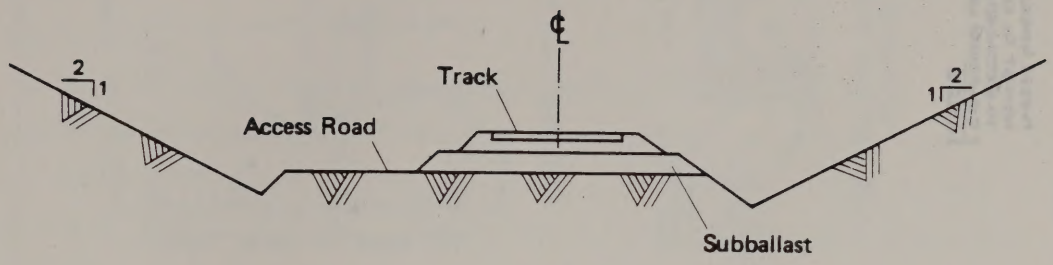
Herbicides would be sprayed to control vegetation on a 12-foot corridor centered on the roadbed; spraying would conform to applicable regulations and to all provisions of the right-of-way permit or easement. Where necessary to prevent fires, grass in the right-of-way would be mowed; it is not anticipated that the entire right-of-way

Typical cut and fill sections are shown in Figure 1.4-27. Typical road crossing configurations and culvert designs are illustrated in Figures 1.4-28 and 1.4-29, respectively.

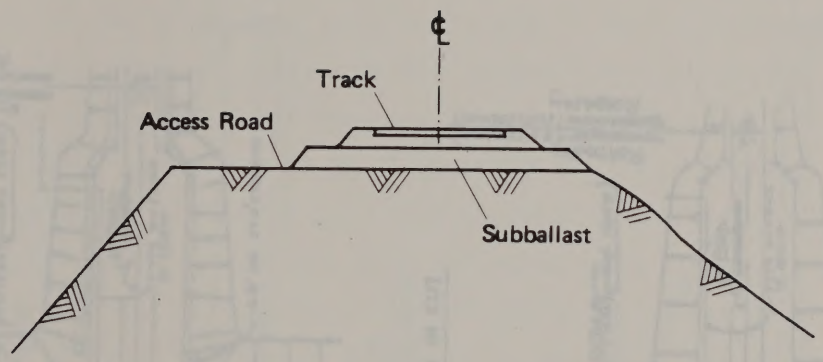
Railroad Operations. Coal hauling would become the responsibility of WyDaho, Inc., as soon as the coal was loaded into railcars at the mine. Four identical unit trains, each with two electric locomotive units and thirty-one 100-ton capacity bottom-dump railcars, would be used to haul the coal. A single unit train would therefore carry 3,100 tons of coal. Train units would be kept together, and used solely for transporting coal between the mine and the plant. During periods when ambient temperature was above freezing, thus allowing the wet process ash to be easily handled, the ash would be returned by train to be buried at the mine during the reclamation process; ash would be transported in separate rail cars designated for this purpose.

A unit train would be approximately 1,300 feet long. Trains would operate at an average speed of 35 miles per hour, passing a given point in approximately 80 seconds. The proposed rail line would have three passing sidings at roughly equal intervals along the route. A train would be dispatched every 1 hour from the mine. Four trains working on an 8-hour cycle (i.e., three trips per day), 6 days per week, 50 weeks per year would transport 11,160,000 tons per year of coal to the gasification plant.

Herbicides would be sprayed to control vegetation on a 12-foot corridor centered on the roadbed; spraying would conform to applicable regulations and to all provisions of the right-of-way permit or easement. Where necessary to prevent fires, trees in the right-of-way would be moved; it is not anticipated that the entire right-of-way

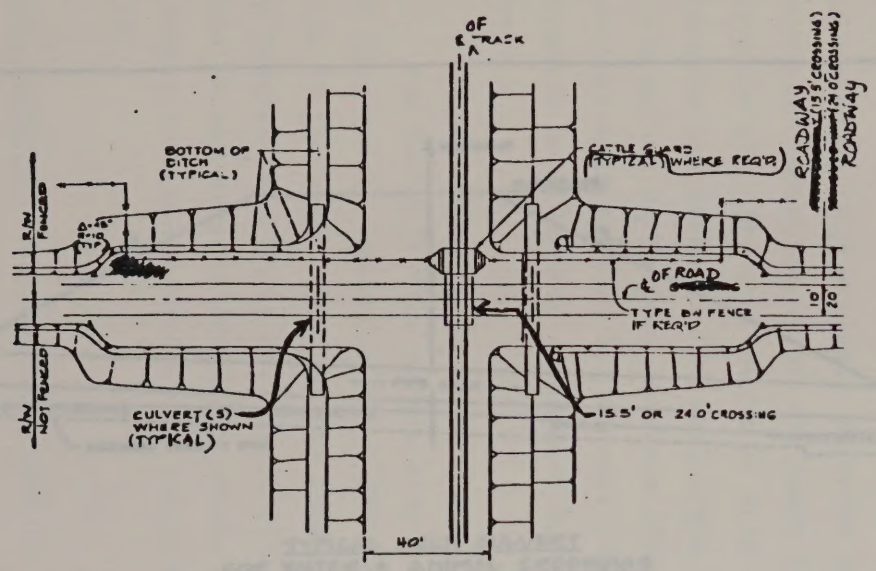


Cut Section

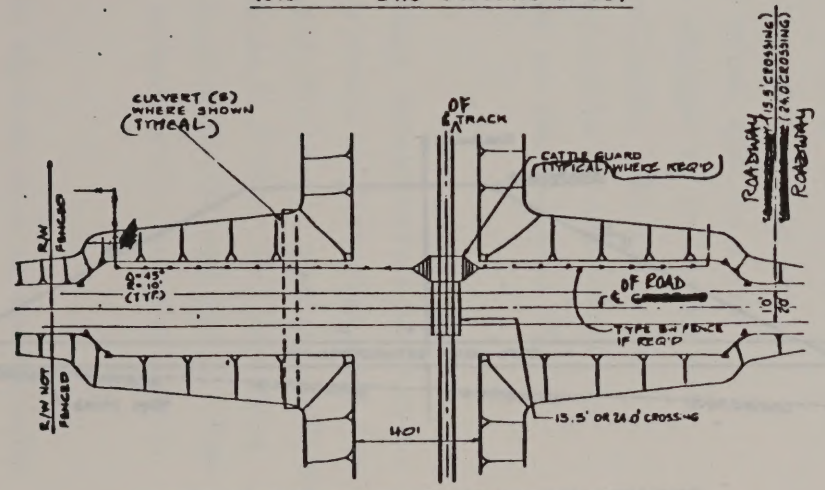


Fill Section

Figure ~~3.5-4~~ 1.4-27
TYPICAL CUT AND FILL SECTIONS



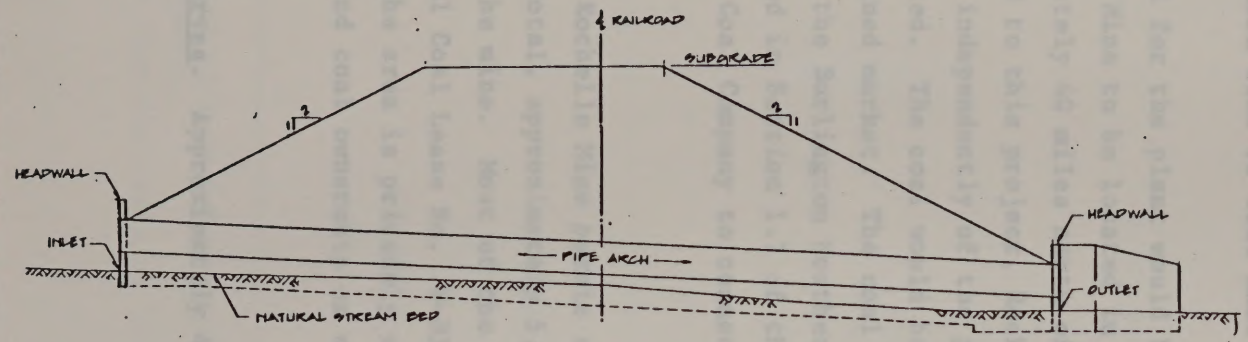
15.5' OR 24.0' CROSSING IN CUT



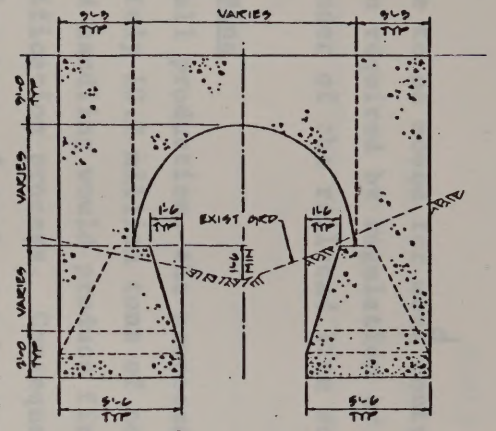
15.5' OR 24.0' CROSSING ON FILL

NOTES
1. CROSSING PROTECTION would BE AS RECOMMENDED BY THE AREA MANUAL OF RECOMMENDED PRACTICE, UNLESS OTHERWISE REQUIRED.

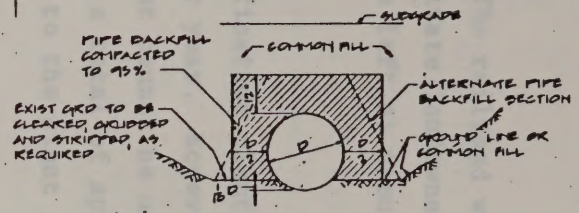
Figure 1.4-28 Typical Road Crossings by Proposed Electric Railroad



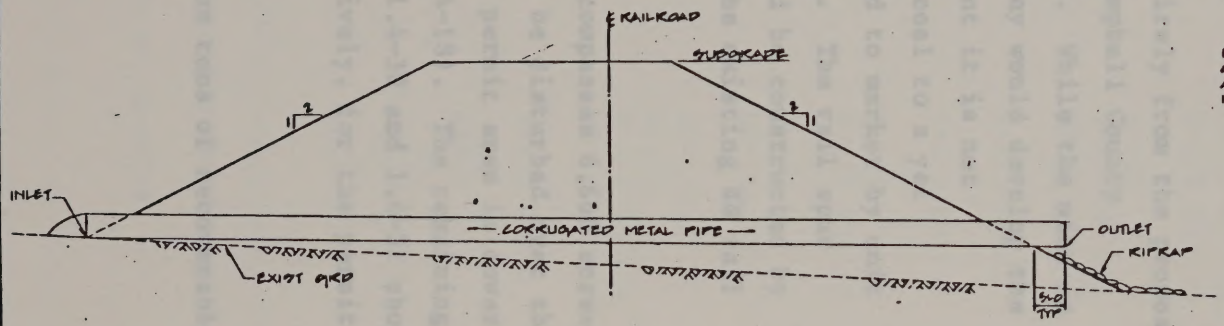
TYPICAL ARCH CULVERT
FOR WATER & ANIMAL CROSSINGS



END VIEW TYPICAL HEADWALL



TYPICAL PIPE INSTALLATION
IN COMMON FILL

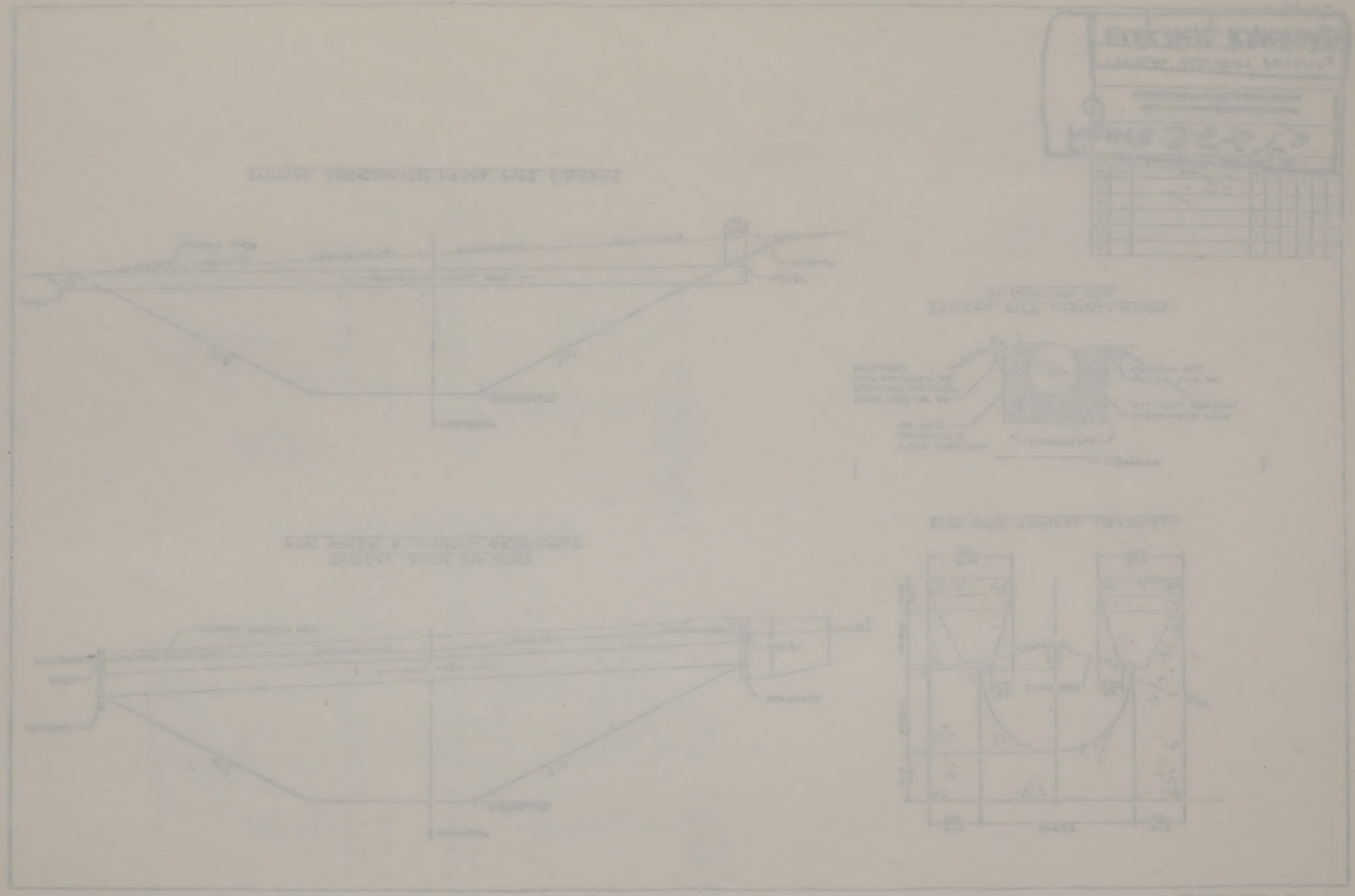


TYPICAL CORRUGATED METAL PIPE CULVERT

Figure 3.5-6

~~WASCO GAS, INC.~~
~~SHUTTLE RAILROAD~~

TYPICAL CULVERT DETAILS,
ELECTRIC RAILROAD



would have to be mowed for weed control. The railroad would be fenced only where required by regulation or at private landowners' request; the remainder of the railroad line would be left as open range.

Rochelle Mine

At full production, the proposed gasification plant would require approximately 10.2 million tons of coal per year. However, coal mining and handling would produce fines that cannot be used in the Lurgi gasification process. Consequently, a total of approximately 10.8 million tons of coal must be supplied to the plant each year.

Coal for the plant would be furnished entirely from the proposed Rochelle Mine to be located in southeastern Campbell County approximately 40 miles north of the plant site. While the mine is dedicated to this project, Rochelle Coal Company would develop the reserves independently of the plant in the event it is not constructed. The coal would be sold as steam coal to a yet undetermined market. The coal would be shipped to market by unit train on the Burlington Northern (BN) railroad. The rail spur identified in Section 1.7 of this Chapter would be constructed by Rochelle Coal Company to connect the mine to the existing BN rail line.

The Rochelle Mine permit area boundary encompasses 6,660 acres. Of this total, approximately 5,210 acres would be disturbed over the life of the mine. Most of the land within the permit area is covered by Federal Coal Lease No. W-0321779 (Table 1.4-18). The remaining land in the area is privately owned. Figures 1.4-30 and 1.4-31 show surface and coal ownership or control, respectively, for the permit area.

Coal Reserves. Approximately 400 to 500 million tons of recoverable

would have to be moved for wind control. The railroad would be moved only where required by regulation or at private landowners' request; the remainder of the railroad line would be left as open range.

Rochelle Mine

At full production, the proposed gasification plant would require approximately 10.2 million tons of coal per year. However, coal mining and handling would produce fines that cannot be used in the Lurgi gasification process. Correspondingly, a total of approximately 10.8 million tons of coal must be supplied to the plant each year.

Coal for the plant would be furnished entirely from the proposed Rochelle Mine to be located in southwestern Campbell County approximately 60 miles north of the plant site. While the mine is dedicated to this project, Rochelle Coal Company would develop the reserves independently of the plant in the event it is not constructed. The coal would be sold as steam coal to a yet undetermined market. The coal would be shipped to market by unit train on the Burlington Northern (BN) railroad. The rail spur identified in Section 1.7 of this Chapter would be constructed by Rochelle Coal Company to connect the mine to the existing BN rail line.

The Rochelle Mine permit area boundary encompasses 6,600 acres. Of this total, approximately 3,310 acres would be disturbed over the life of the mine. Most of the land within the permit area is covered by Federal Coal Lease No. W-0121172 (Table 1.4-18). The remaining land in the area is privately owned. Figures 1.4-30 and 1.4-31 show surface and coal ownership or control, respectively, for the permit area.

Coal Reserves. Approximately 400 to 500 million tons of recoverable

TABLE 1.4-18

AREA AFFECTED BY ROCHELLE COAL MINE
FEDERAL COAL LEASE NO. W-0321779

Township	Range	Section	Affected Portions
T. 41 N.	R. 69 W.	6	All[a]
		7	Lots 1, 2, 3, 4, NE-1/4, E-1/2 W-1/2, W-1/2 SE-1/4
		18	E-1/2 NW-1/4, W-1/2 NE1/4
	R. 70 W.	1	E-1/2, E-1/2 W-1/2, SW-1/4 SW-1/4
		2	S-1/2 S-1/2
		3	S-1/2 S-1/2
		10	N-1/2, N-1/2 SE-1/4
		11	N-1/2, NE-1/4 SE-1/4
		12	NE-1/4, W-1/2, N-1/2 SE-1/4, SE-1/4 SE-1/4
T. 42 N.	R. 69 W.	30	S-1/2 S-1/2
		31	All
	R. 70 W.	25	S-1/2 S-1/2
		36	All[b]

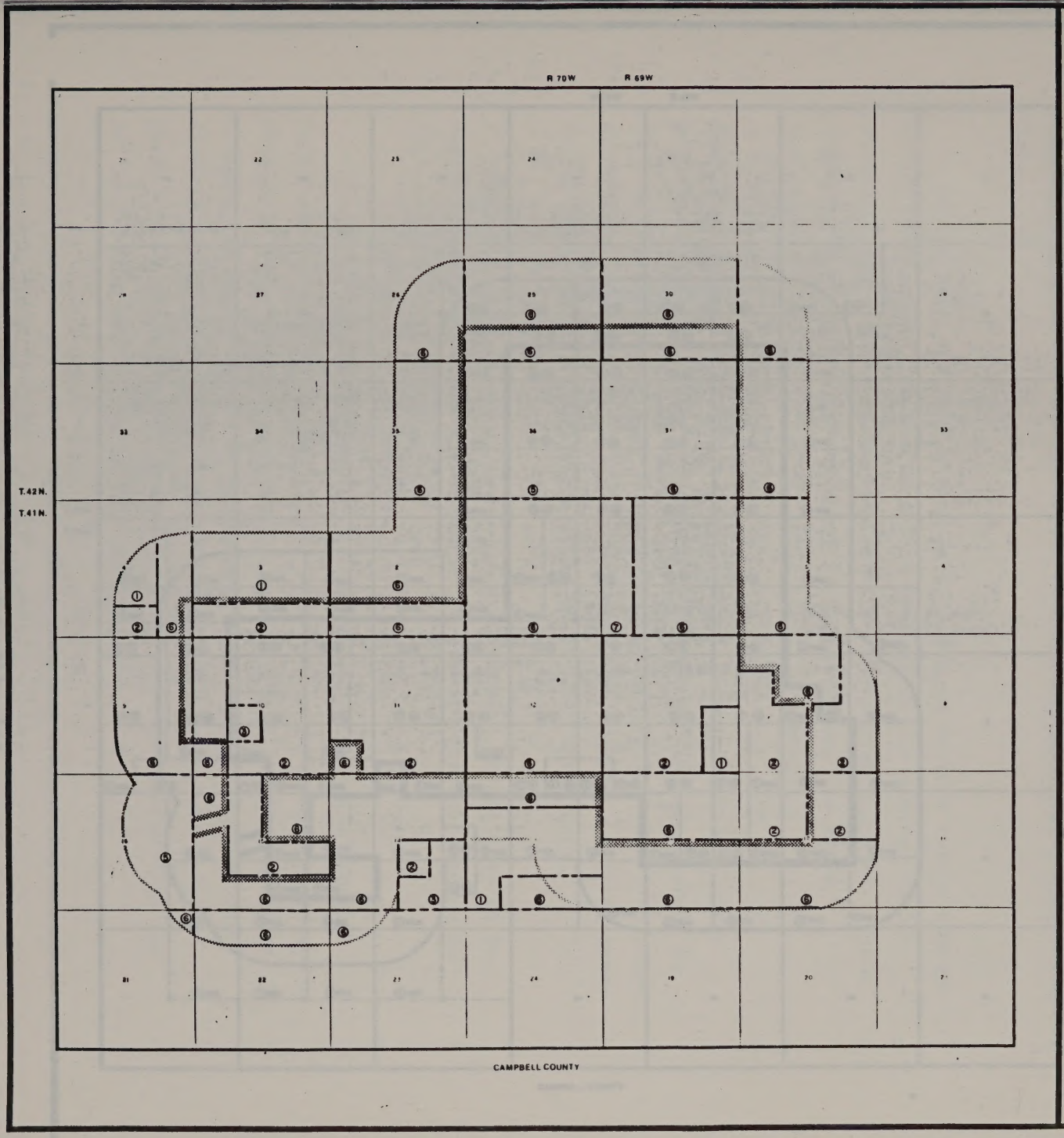
[a]The W1/2 W1/2 is being purchased from Mary Rapelye under Agreement No. 455-012.
[b]Leased from the state of Wyoming under Lease No. 0-26749.

TABLE 1.4-18

AREA AFFECTED BY BOONVILLE COAL MINE
FEDERAL COAL LEASE No. W-0232172

Township	Range	Section	Affected Portions
T. 41 N.	R. 69 W.	6	All[a]
		7	Lots 1, 2, 3, 4, NE-1/4, E-1/2 W-1/2, W-1/2 SE-1/4
		18	E-1/2 NE-1/4, W-1/2 NE1/4
	R. 70 W.	1	E-1/2, E-1/2 W-1/2, SW-1/4 SE-1/4
		2	E-1/2 E-1/2
		3	E-1/2 E-1/2
		10	E-1/2, W-1/2 SE-1/4
		11	E-1/2, NE-1/4 SE-1/4
		12	NE-1/4, E-1/2, E-1/2 SE-1/4, SE-1/4 SE-1/4
T. 42 N.	R. 69 W.	32	E-1/2 E-1/2
		33	All
	R. 70 W.	25	E-1/2 E-1/2
		36	All[b]

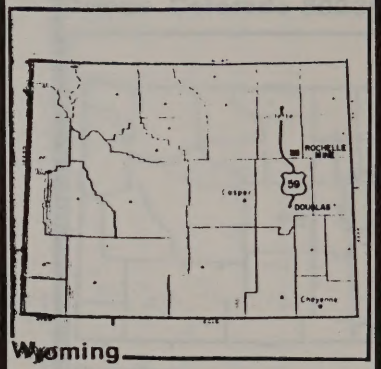
[a]The W1/2 W1/2 is being purchased from Duty Energies under agreement No. 4232-012.
[b]Leased from the state of Wyoming under Lease No. 0-32142.



Rochelle Coal Company

Rochelle Mine

12015 East 46th Ave.
Denver, Colorado 80239



Wyoming

Legend

PERMIT BOUNDARY
½ MILE OUTSIDE PERMIT BOUNDARY
DILTS JOHN C.
PEABODY COAL CO.
DILTS, JOHN, JERRY, STEVEN
MACKEY, ROBERT & DOROTHY
STATE OF WYOMING
FEDERAL
RAFELEYE, MARY L. et. al.

Fig. 1.4-30
Rochelle Mine
Surface
Ownership

Scale: 1 ½ 0 1 Miles

North

OWNERSHIP
SURFACE
Appendix A-B

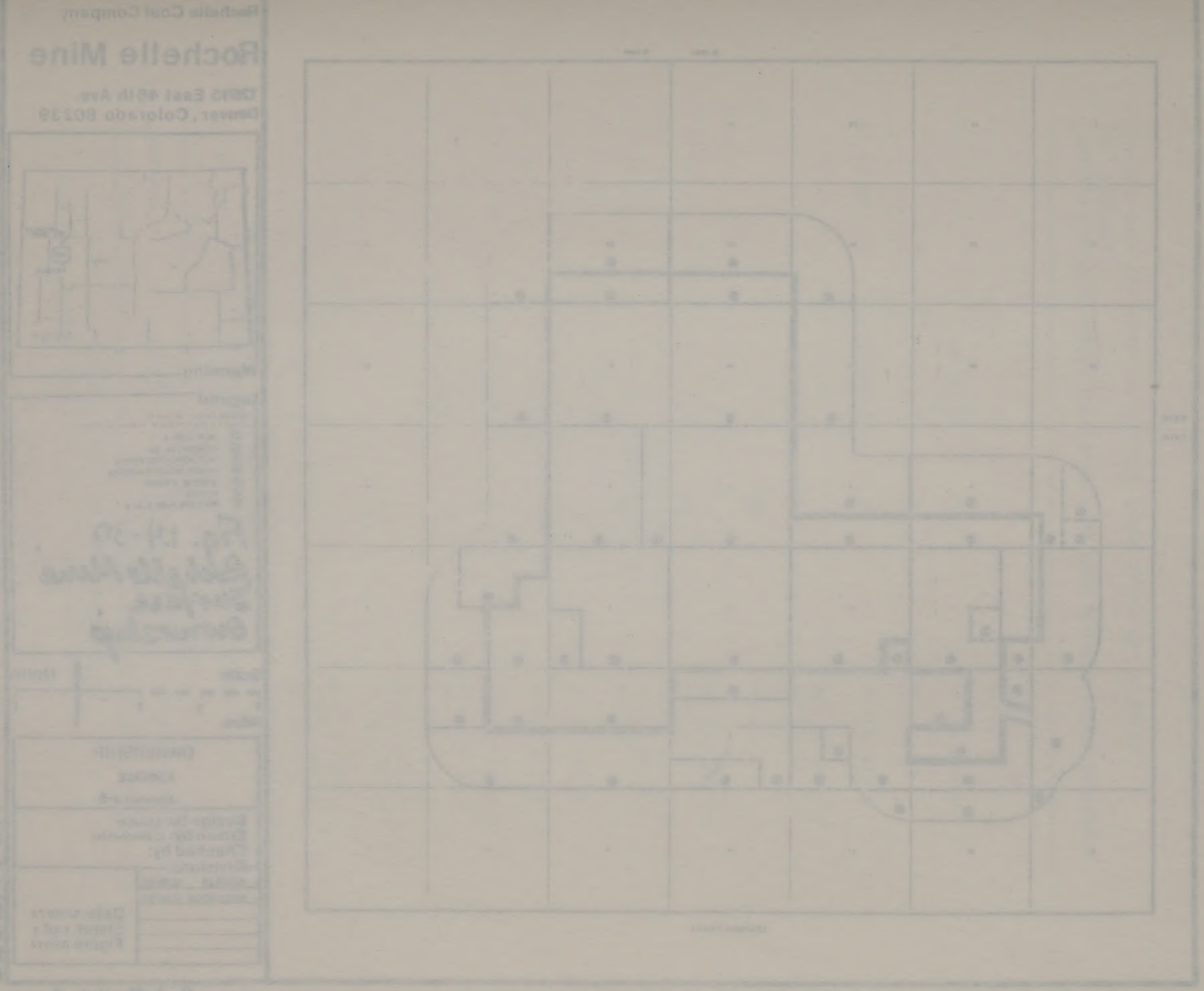
Design by: V.Garber
Drawn by: C.Winchester
Checked by:
Revisions:
S. DOPLER 12/19/80
S. McCASTON 12/19/80

Date: 5/30/79
Sheet 1 of 1
Figure R.P.012

ROCHELLE

Rochelle Ntbk A
100

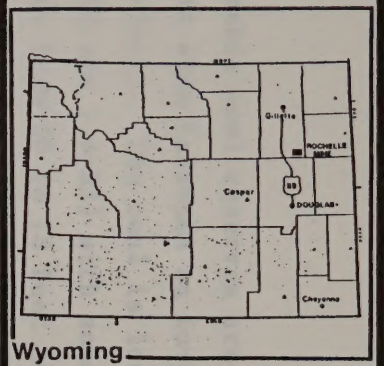
1-94



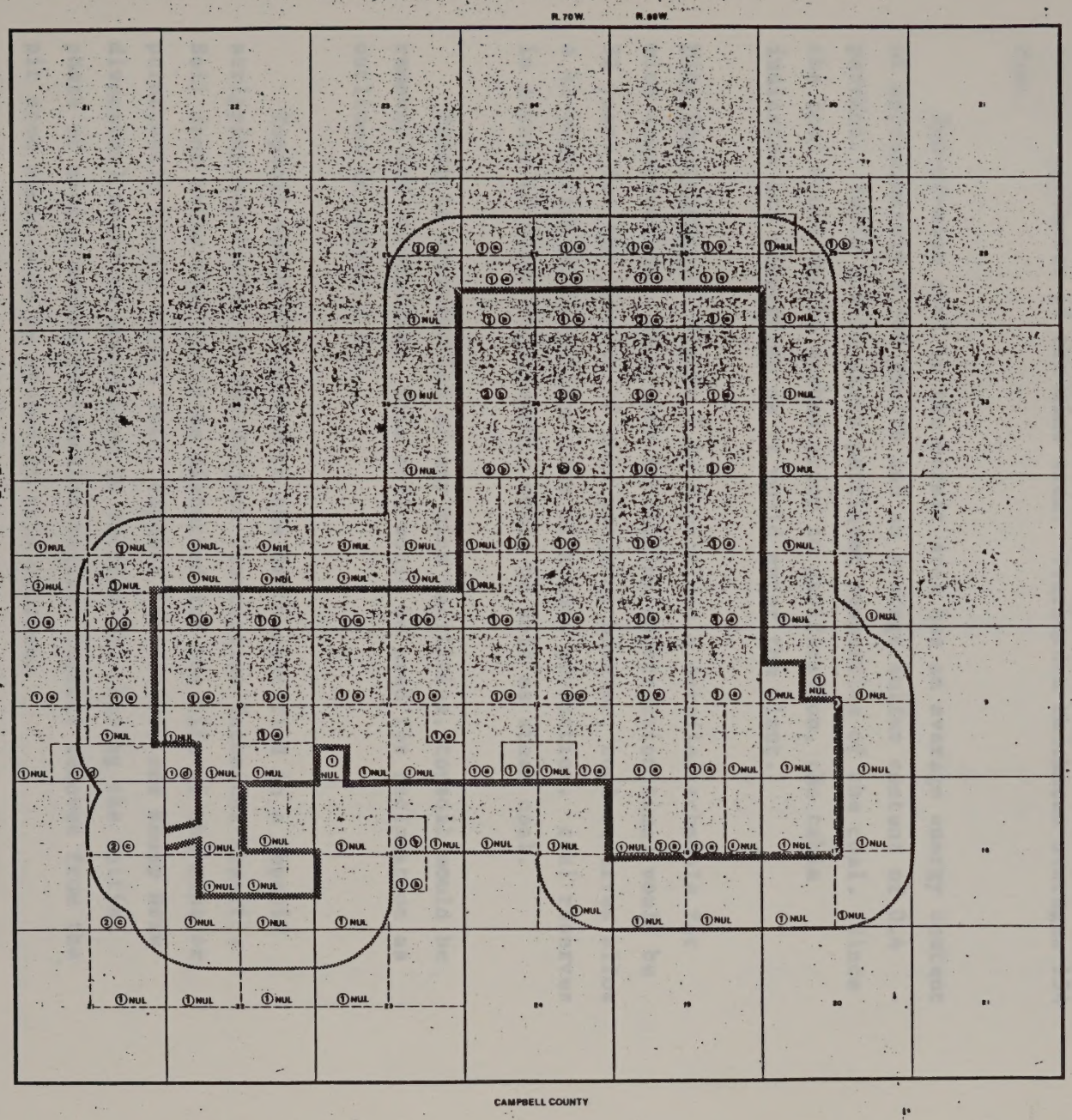
Rochelle Coal Cor ıy

Rochelle Mine

12015 East 46th Ave.
Denver, Colorado 80239



Wyoming



Legend

PERMIT BOUNDARY
½ MILE OUTSIDE PERMIT BOUNDARY
OWNER
① USA
② WYOMING
LESSEES
a ROCHELLE COAL COMPANY
b PEABODY COAL COMPANY
c BAUM COAL COMPANY
d NORTH ANTELOPE COAL COMPANY
NUL - NOT UNDER LEASE

1, 4-31

Fig. Rochelle Mine Coal Ownership

Scale — Miles: 1 ½ 0 1

North

OWNERSHIP

COAL

Appendix A-B

Design by: DW DOPLER
Drawn by: S McCASTON
Checked by:
Revisions:

D. DOPLER	12/19/80
S. McCASTON	12/19/80

Date: 11/9/79
Sheet 1 of 1
DWg No 268-A-001-P

ROCHELLE

Rochelle Nbk A

100

1-95

Rochelle Coal Corp.

Rochelle Mine

12015 East 48th Ave.
Denver, Colorado 80239

Wyoming

Scale

Owner/Agent

Drawn by
Checked by

Date
Sheet 1 of 1
Drawing

ROCHELLE

Public Site A

strippable coal reserves are estimated to underlie the Rochelle Mine permit area (assumes an in-place coal density of 1,740 tons per acre-foot). The coal is located primarily in the Roland seam (Figures 1.4-32 and 1.4-33) with some overlying riders. The seam thickness ranges from 20 to 78 feet and averages 66 feet. Coal thickness and quality is extremely variable along a burn wedge on the southern and eastern perimeter of the mine area. Overburden thickness averages 134 feet.

Run-of-mine coal in the permit area has an average energy content of approximately 8,500 Btu/lb and an average sulfur content of 0.4 percent. Table 1.4-19 lists pertinent properties of the coal. Since the coal would not be washed prior to gasification, the table indicates its properties as it would enter the plant.

Mine Construction. Figure 1.4-34 provides a detailed schedule for mine construction. Mine life (including construction time) would be 32 years for the purpose of this project; however, coal reserves allow a 42-year life at 11 million tons of annual production. coal reserves in excess of plant requirements would be sold as steam coal.

Prior to construction of any mine facilities, topsoil would be removed and stockpiled. This soil would be used for reclamation as outlined in Appendix A-1.

Topsoil would be removed to the depth specified in a topsoil stripping map (refer to the Project Description Technical Report). Soil from areas that would be disturbed for the life of the mine or permanently (i.e., access road, support facilities, and Knapp Draw diversion) would be stockpiled in section 15. During the initial phase of mining before reclamation begins, topsoil removed from the pit area would also be stored in this section.

TABLE 1.4-19

ROLAND COAL ANALYSIS, ROCHELLE MINE

Proximate Analysis	Typical Value	Range	
(As Received)			
Moisture	27.43	25.5	30.5
Ash	5.21	4.0	8.0
Volatile	31.96	28.5	36.5
Fixed Carbon	35.40	31.5	39.5
Btu/lb	8,520	8,150	8,900
Sulfur	0.24	0.2	0.6
Sulfur Forms Dry Basis			
Pyritic	0.02	0.0	0.1
Sulfate	0.01	0.0	0.1
Organic	0.30	0.2	0.5
Water Soluble Alkalies			
Na_2O	0.147	0.100	0.200
K_2O	0.007	0.000	0.025
Equilibrium Moisture	24.43	23.5	25.5
Ultimate Analysis Dry Basis			
Carbon	67.92	64.0	74.0
Hydrogen	4.55	3.5	6.0
Nitrogen	0.92	0.7	1.2
Chlorine	0.06	0.0	0.15
Sulfur	0.33	0.2	0.8
Ash	7.18	5.9	10.4
Oxygen	19.04	16.0	21.0

Source: Rochelle Coal Company (analysis presented December 2, 1980).

Indicated ranges based on 95 percent of the samples from approximately 10,000 ton shipments sampled at the mine in accordance with ASTM Standards. All analyses are subject to revision due to additional coring, conditions specified in the coal supply agreement, actual operating conditions at time of mining, type of preparation at time of mining, or federal and state regulations. Analysis intended for informational purposes only. Assumptions: 1) Equilibrium Moisture plus 3.0% for production moisture. 2) 3 inches of extraneous material added.

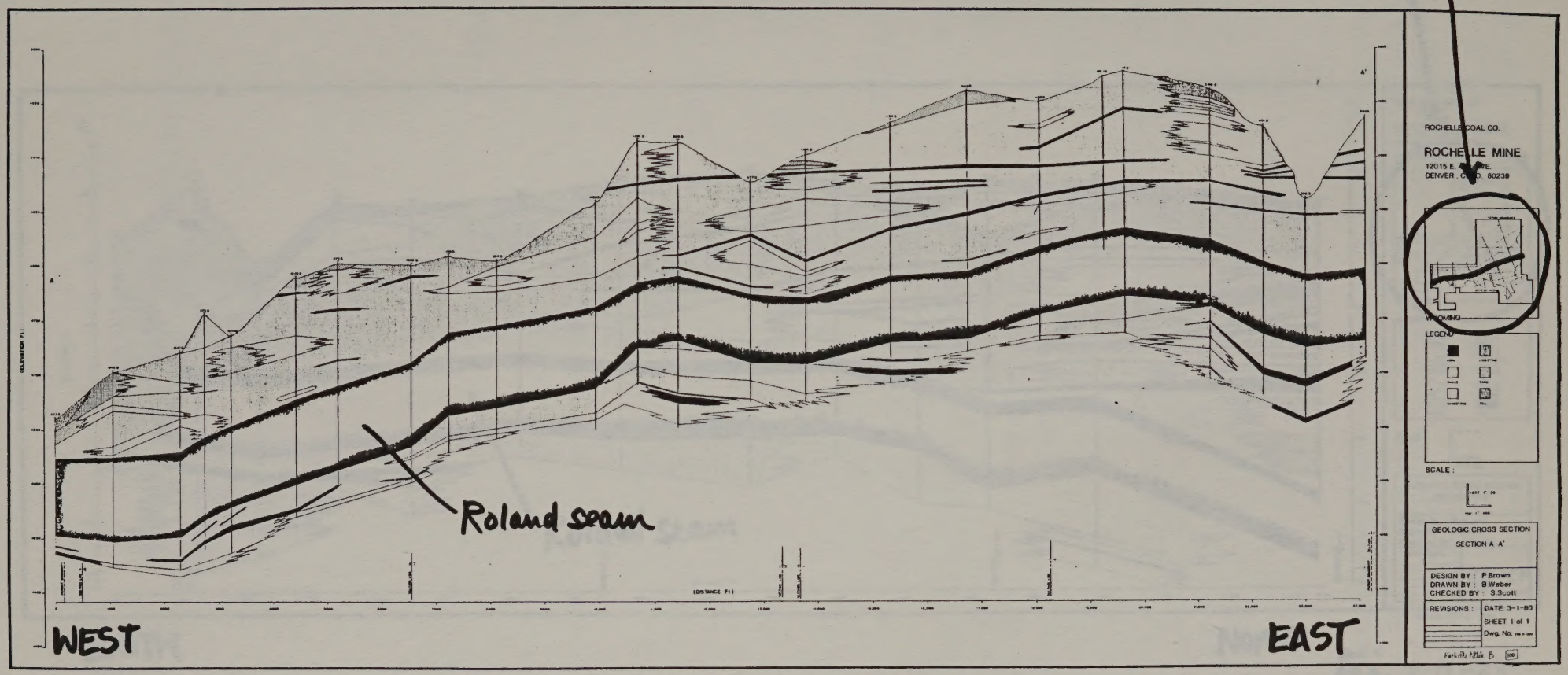
TABLE 1.4-19

SOLAND COAL ANALYSES, SCHEELITE MINE

Proximate Analysis	Typical Value	Range	
(As Received)			
Moisture	37.41	33.3	38.5
Ash	5.21	4.0	5.0
Volatile	31.96	28.5	34.5
Fixed Carbon	25.40	21.3	29.5
Btu/lb	8,520	8,130	8,900
Sulfur	0.14	0.2	0.6
Sulfur Forms Dry Basis			
Pyritic	0.02	0.0	0.1
Sulfate	0.01	0.0	0.1
Organic	0.10	0.1	0.3
Water Soluble Alkalies			
Na_2O	0.147	0.100	0.300
K_2O	0.007	0.000	0.015
Equilibrium Moisture	34.47	33.3	35.3
Ultimate Analysis Dry Basis			
Carbon	67.22	64.5	74.5
Hydrogen	4.53	3.3	5.5
Nitrogen	0.92	0.7	1.2
Chlorine	0.08	0.0	0.15
Sulfur	0.33	0.2	0.5
Ash	7.14	5.9	10.4
Oxygen	19.94	16.0	21.4

Source: Rochelle Coal Company (analysis measured December 2, 1980).

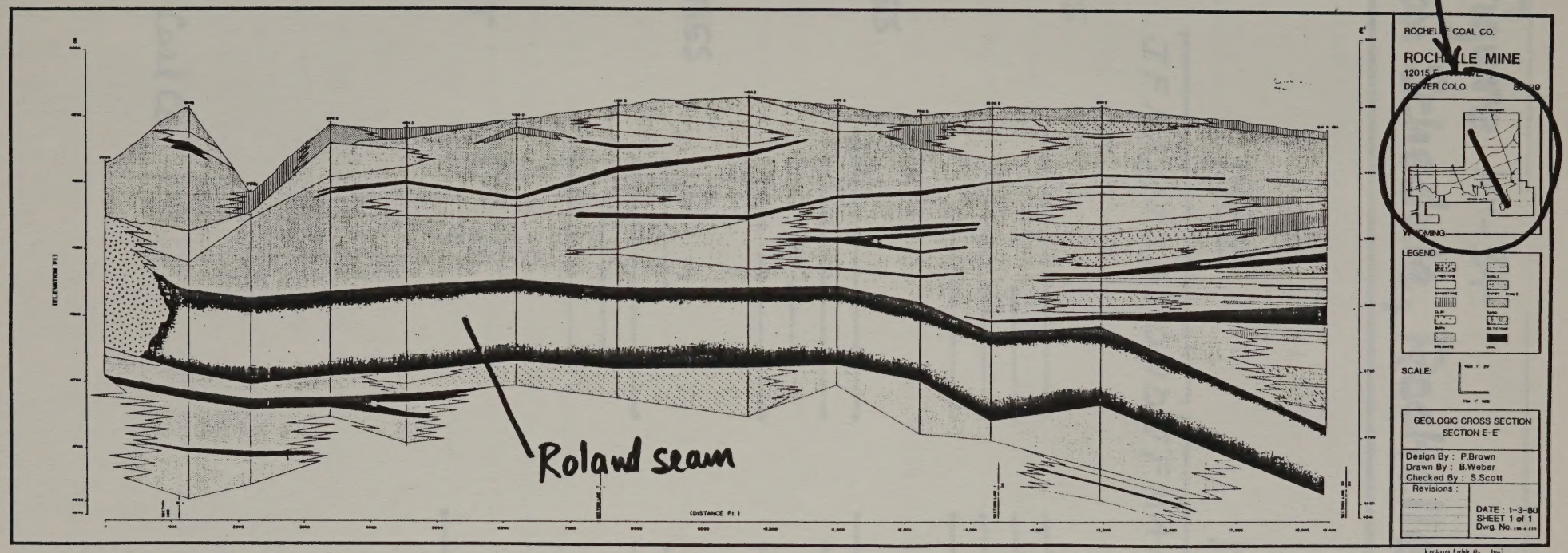
Indicated ranges based on 95 percent of the samples from approximately 10,000 tons shipments sampled at the mine in accordance with ASTM Standards. All analyses are subject to variation due to geological cycle, conditions specified in the coal supply agreement, actual operating conditions on time of mining, type of preparation at time of mining, or federal and state regulations. Analysis intended for informational purposes only. Assumptions: 1) Equilibrium moisture plus 3.0% for production moisture. 2) 5 inches of extraneous material added.



Include inset

Fig. 1.4-32
Geologic Cross Section 1

include inset

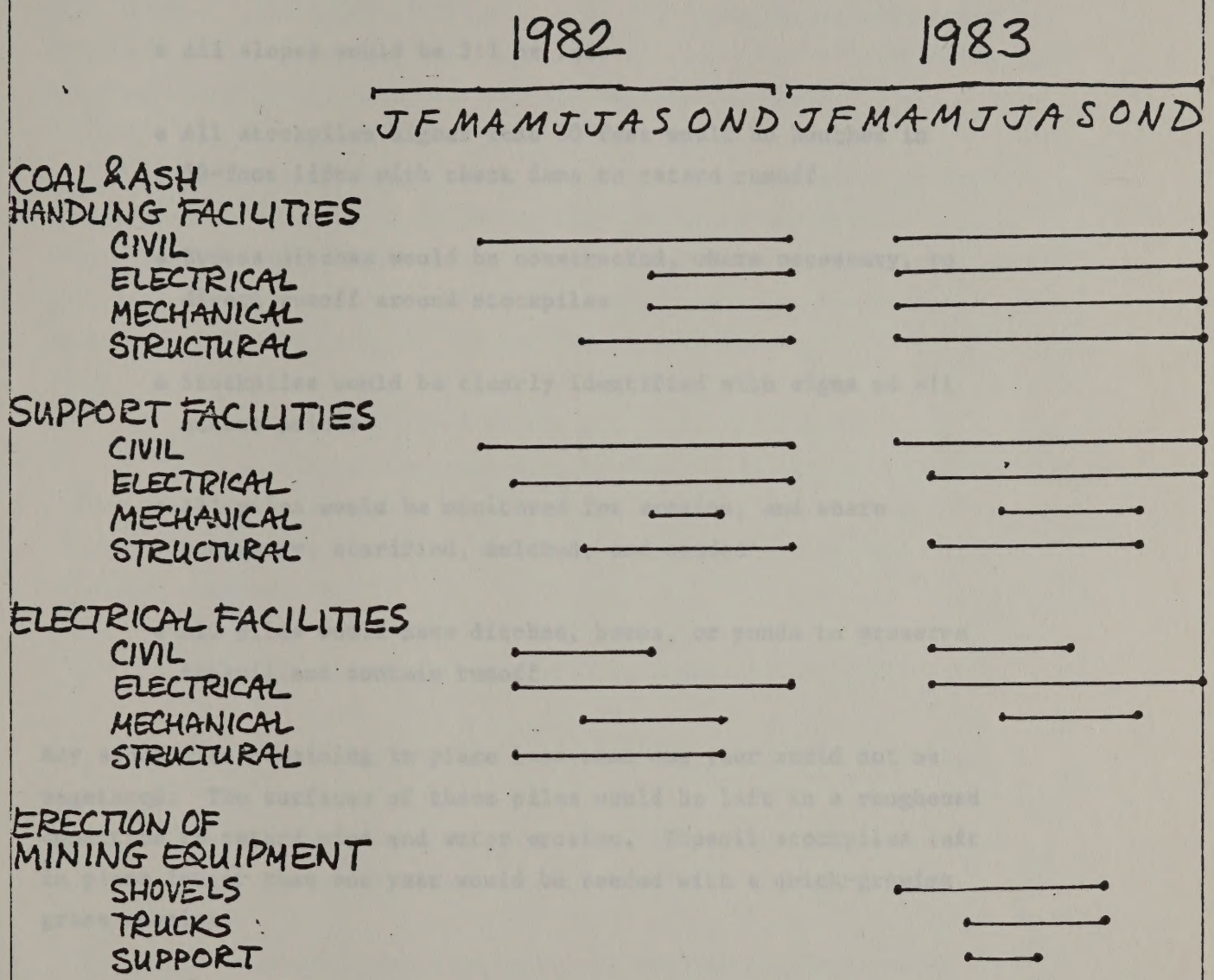


SOUTH

NORTH

Fig. 1.4-33
Geologic Cross Section 2

Figure 1.4-34
Construction Schedule, Rochelle Mine



Source: Rochelle Coal Co.

The following procedures would be used for all topsoil stockpiles:

- All slopes would be 3:1 or less
- All stockpiles higher than 50 feet would be benched in 50-foot lifts with check dams to retard runoff
- Bypass ditches would be constructed, where necessary, to divert runoff around stockpiles
- Stockpiles would be clearly identified with signs at all access points
- All piles would be monitored for erosion, and where necessary, scarified, mulched, and seeded
- All piles would have ditches, berms, or ponds to preserve topsoil and contain runoff

Any stockpiles remaining in place less than one year would not be vegetated. The surfaces of these piles would be left in a roughened condition to retard wind and water erosion. Topsoil stockpiles left in place longer than one year would be seeded with a quick-growing grass species.

Primary access to the mine would be from State Highway 59, approximately eight miles south of Reno Junction; east along the Reno County road; south and east along Piney Canyon Road; and southeast along a 30-foot-wide, 5.3-mile access road to be completed into the permit area. All roads on this primary access route from the mine to

State Highway 59 would be paved with a chip-and-seal surface to secondary highway standards. Haul roads and ramps would be constructed as required to active mining areas during operation. Haul, access, and light-duty (i.e., roads providing occassional access to power lines, survey markers, data collection points, and premining drilling sites) road specifications are outlined in Table 1.4-20.

Road surfaces would be graded to minimize dust and mud. Culverts with a minimum diameter of 24 inches would be installed where significant drainages are crossed. Active haul roads would be sprayed with water to suppress dust. A chemical dust suppressant or binder would be applied to roads in use for more than 6 months.

The railroad terminal loop at the mine (Figure 1.4-35) would be constructed according to the procedures described for the electric railroad above. The proposed location of the loop and adjacent line in the Porcupine Creek valley was dictatd by the following constraints.

- Railroad should not be located over recoverable coal
- Grades must not exceed 1 percent compensated for curvation
- Loop curvature must be less than 7.5° on the loaded site and 8° on the empty side, without excessive cut and fill
- Railroad must avoid eagle roosts and nests in the valley

The location of the loop would require diversion of Porcupine Creek, as described below.

A short siding would be constructed off the rail loop (Figure

TABLE 1.4-20

ROAD DESIGN SPECIFICATIONS, ROCHELLE MINE

Key[a]	Description	Haul Roads	Access Road	Light Use Roads
a.	Lane edge to ditch centerline	8-12'	8-12'	2'
b.	Width of driving surface	80'	30-60	10'
c.	Cross slope	24h:1v	24h:1v	24h:1v
d.	Combined surface plus subbase[b]	12-48"	12-48"	variable
e.	Ditch out slope (angle of repose in rock - 0.25h:1v) (MAX)	1.5h:1v	1.5h:1v	1.5h:1v
f.	Depth at ditch center line[b]	--	--	--
g.	Ditch slope adjacent to roadway	2h:1v	2h:1v	2h:1v
h.	Extra road width for safety berm (if required)	20'	12'	none
i.	Safety berm height is rolling radius of largest tire	5'	3'	none
j.	Berm support (subbase material)	scoria	N/A	N/A
k.	Fill slope (MAX)	2h:1v	2h:1v	2h:1v
l.	Fill bench when slope exceeds 1:1	N/A	N/A	N/A

Source: U.S. Bureau of Mines Circular 8758, "Design of Surface Mine Haul Roads-A Manual."

[a]Refer to Figure 3.4-9.
[b]To be determined by site-specific conditions.

TABLE 1.4-23

MOAB DESIGN SPECIFICATIONS, SPECIALIZED RIGS

Key[a]	Description	Hauf Creek	Jacobs Ranch	Eagle Gas Scale
a.	Lane edge to ditch centerline	8-12'	8-12'	2'
b.	Width of driving surface	20'	30-40	18'
c.	Cross slope	2%:1v	3%:1v	4%:1v
d.	Combined superelevation and crossslope[b]	12-24"	12-24"	variable
e.	Ditch and slope (angle of repose in rock - 0.75%:1v (MAX)	1.5%:1v	1.5%:1v	2.5%:1v
f.	Depth at which ripper line[b]	--	--	--
g.	Ditch slope adjacent to roadway	3%:1v	3%:1v	3%:1v
h.	Space road width for safety berm (if required)	30'	12'	none
i.	Safety berm height in multiple radius of largest size	2'	2'	none
j.	Area support (rubber material)	acceptable	N/A	N/A
k.	Fill slope (MAX)	3%:1v	4%:1v	2%:1v
l.	Fill sands when slope exceeds 1v1	N/A	N/A	N/A

Source: T.J. Kosaka of Mines Corporation Rig. "Design of Surface Mine Haul Roads-A Manual."

[a]Refer to Figure 3.4a9.
[b]To be determined by site-specific conditions.

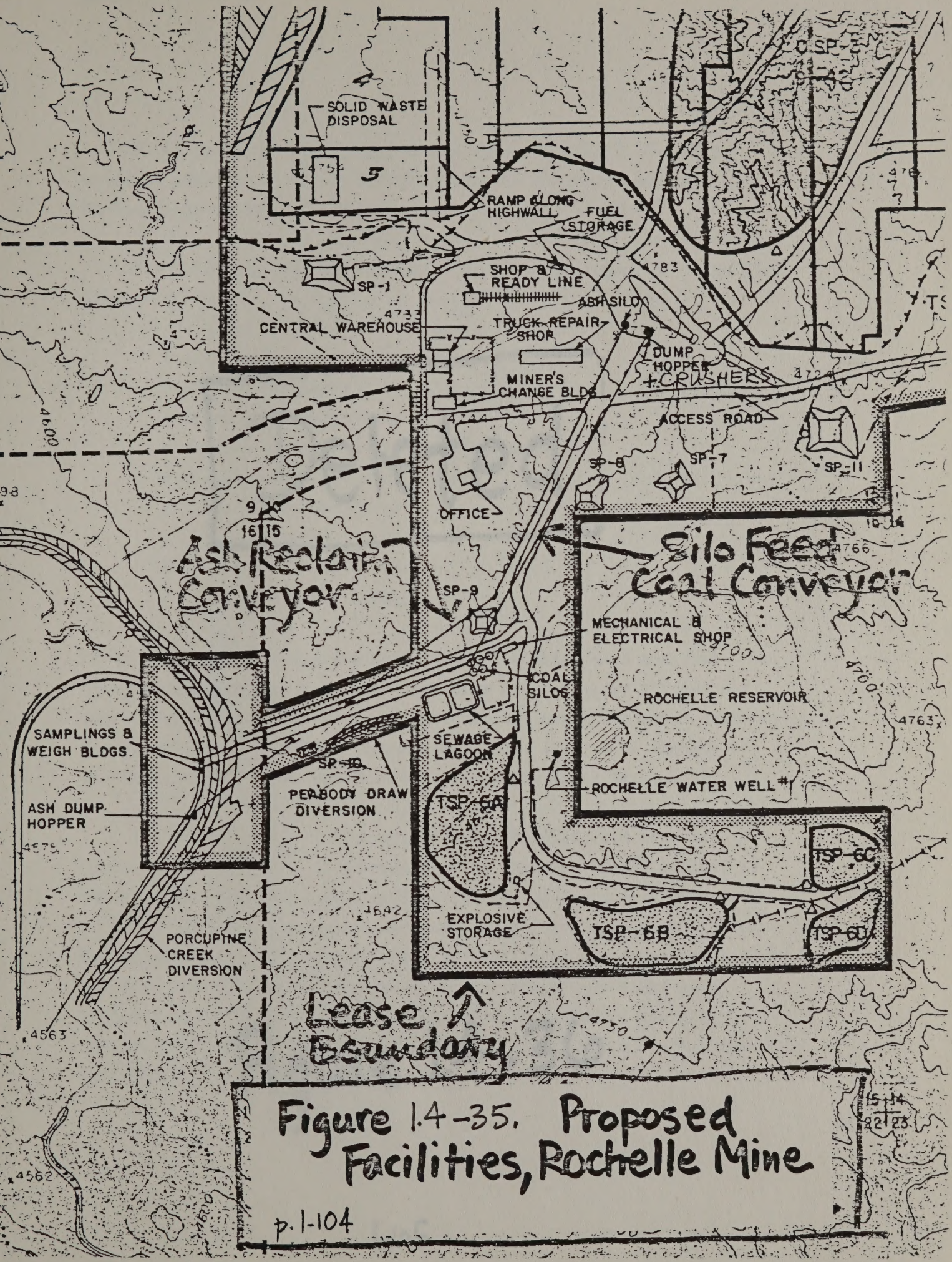


Figure 1.4-35. Proposed Facilities, Rochelle Mine

Deleted

Figure 1.4-36

1.4-35) to facilitate unloading of ash from the plant. The siding would be equipped with a dump hopper beneath the rail connected by a 36-inch wide convey to a storage silo.

The following support facilities would be constructed at the mine (Figure 1.4-35):

- office building
- central warehouse
- shower and change room
- mechanical and electrical shop and yard
- truck and tractor repair shop
- truck maintenance area
- fueling station
- ash handling facilities
- coal loadout facilities

Prior to actual construction activities, a staging area would be cleared of vegetation and other obstacles for temporary offices and construction materials storage. Construction materials would move to the staging area largely by truck from Casper along U.S. Highway 87 and State Highway 387, and from Gillette along State Highway 59.

All foundations would be constructed of reinforced concrete. Concrete work would be in accordance with Standard Specifications of the American Concrete Institute (ACI-38-71). All steel structures would be designed, fabricated, and erected in accordance with Standard Specifications for Structural Steel for buildings as adopted by the American Institute of Steel Construction. Structures would be designed on the basis of the American National Standard for structures in this geographical location (A.S.A. A58.1-1972) for a 50-year mean recurrence interval for snow and wind.

Before, during, and after mining operations, surface water flow would be controlled in order to minimize impacts to water quality and quantity. This control would be accomplished by berms, channels, and culverts constructed to direct flow away from mining facilities and activities, where this is feasible, and ditches and sedimentation ponds to collect, clarify, and discharge flows that cannot be diverted. Design details have been developed for control facilities to be used during mining years 1 through 5 (Figure 1.4-37). These controls are discussed briefly below.

Porcupine Creek Diversion: a channel, approximately 8 miles long, to direct Porcupine Creek around the proposed railroad loop. This would be a temporary feature, to be filled, graded, and reclaimed at the conclusion of mining.

Peabody Draw Diversion: a channel and berm, approximately 3/4 mile long, to direct Peabody Draw away from the conveyor corridor. This would be a temporary structure.

Knapp Draw Diversion: a channel, approximately 4 miles long, to direct Knapp Draw away from the active mining area. This would be a permanent feature, eventually forming the post-mining channel for Knapp Draw.

Sedimentation Ponds: there would be 10 excavated reservoirs, nine of which would be temporary, and one permanent. All would collect runoff diverted by ditch from the mining and post-mining area, until the surface has been revegetated. In addition, Reservoir SP-1 (Figure 1.4-37) would collect water pumped from the mine pit, and washdown from the coal and ash handling facilities. This reservoir would be left intact at the

(TO BE REVISED)

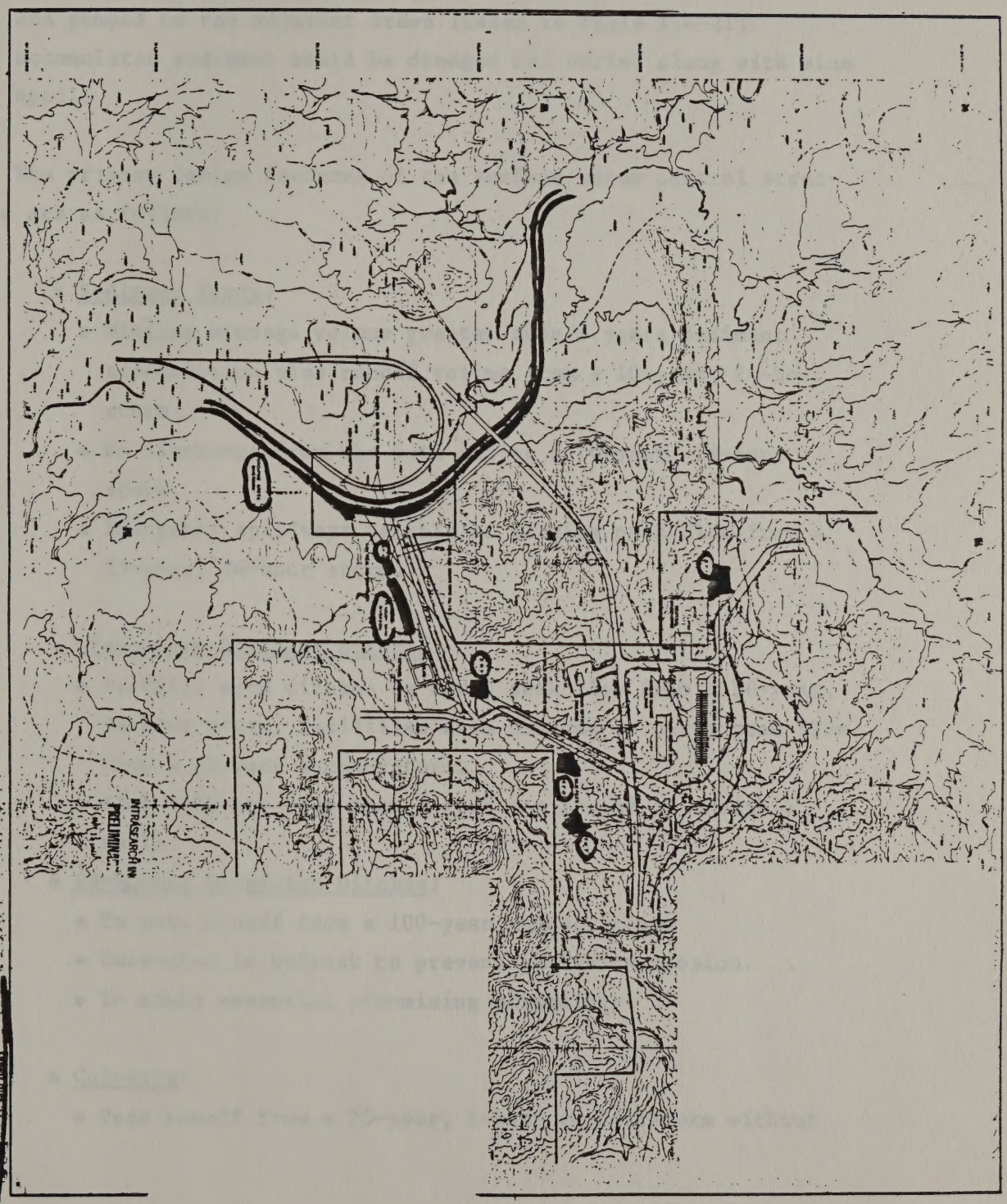


Figure 1.4-37 Surface Water Control, Rochelle Mine

completion of mining, to replace a private stock pond that would be removed during mine development. In the course of normal mine operation, the collected runoff in all 10 ponds would be settled and pumped to the adjacent draws listed in Table 1.4-21; accumulated sediment would be dredged and buried along with mine spoil.

The primary design features of the surface water control structures are as follows:

- Sediment Ponds:
  - Minimum storage volume greater than 3 years sediment accumulation plus runoff volume from a 10-year, 24-hour storm.
  - No discharge from the pond during a 10-year, 24-hour storm.
  - Emergency spillways capable of passing peak flow from a 25-year, 24-hour storm.

- Temporary Drainage Ditches:
  - Backfill area ditches to carry peak flow from a 10-year, 24-hour storm; facilities area ditches to carry peak flow from a 25-year thunderstorm.
  - Flow velocity less than 3 feet per second on erodable soils.
- Permanent Diversion Ditches:
  - To pass runoff from a 100-year thunderstorm.
  - Excavated in bedrock to prevent excessive erosion.
  - To mimic essential pre-mining morphology.

- Culverts:
  - Pass runoff from a 25-year, 1-hour thunderstorm without

completion of mining, in regions a private stock pond that would be removed during mine development. In the course of normal mine operation, the collected runoff in all 10 ponds would be settled and pumped to the adjacent areas listed in Table 2.4-11; accumulated sediment would be dredged and buried along with mine spoil.

The primary design features of the surface water control structures are as follows:

- Sediment Ponds:
  - Minimum storage volume greater than 3 years sediment accumulation plus runoff volume from a 10-year, 24-hour storm.
  - No discharge from the pond during a 10-year, 24-hour storm.
  - Emergency spillways capable of passing peak flow from a 25-year, 24-hour storm.

- Temporary Drainage Diversions:
  - Erosion resistant spillways to carry peak flow from a 10-year, 24-hour storm; Emergency spillways capable to carry peak flow from a 25-year 24-hour storm.
  - Flow velocity less than 5 feet per second on erodible soils.

- Permanent Diversions Ditches:
  - To pass runoff from a 100-year thunderstorm.
  - Excavated in bedrock to prevent excessive erosion.
  - To minimize essential post-mining morphology.

- Culverts:
  - Pass runoff from a 25-year, 1-hour thunderstorm without

Table 1.4-21

SEDIMENTATION PONDS AND DISCHARGE LOCATIONS, ROCHELLE MINE

Reservoir Designation	Discharged to :
SP-1	Red Draw
SP-2	Deer Mouse Draw
SP-3	Badger Draw
SP-4	Badger Draw
SP-5	Jackalope Draw
SP-6	Skunk Draw
SP-7	Red Fox Draw
SP-8	Coyote Draw
SP-9	Rattlesnake Draw
SP-10	Peabody Draw

impounding water at the upstream end, and from a 100-year, 24-hour precipitation event, if warranted for certain facilities.

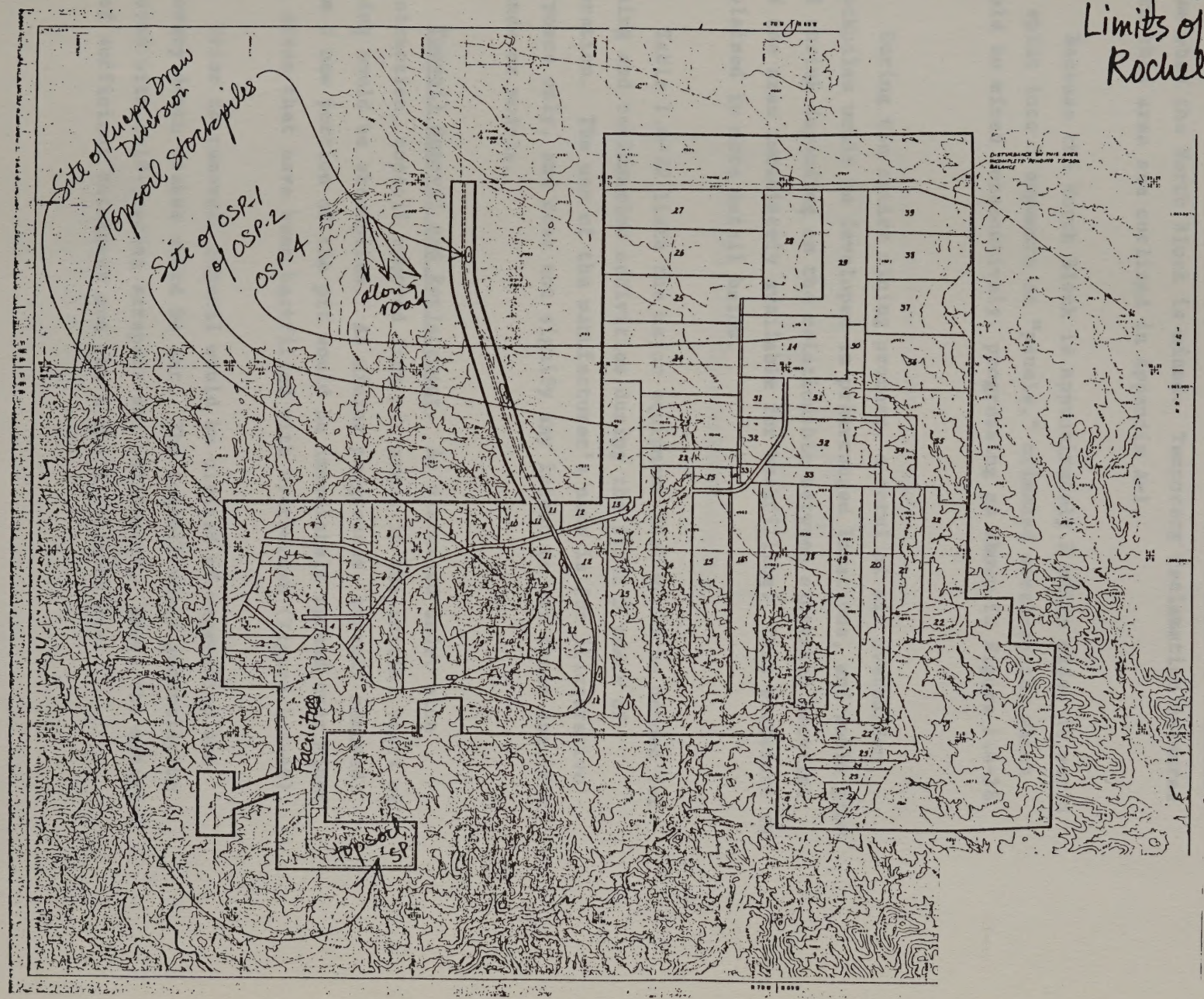
- To have erosion protection at discharge point if velocity exceeds 6 feet per second in a 25-year, 1-hour event.

Heavy mining equipment, particularly electric shovels and large-capacity haulers for overburden and coal, would be brought in sections to the mine site. Equipment would be assembled on a site near the mine buildings, and moved to the initial mining area several months in advance of the beginning of coal production, to allow time for equipment checks and initial topsoil and overburden removal.

Mine Operation. For the purpose of the EIS, mine operation would begin in the second year of mine development. In that year, the permanent diversion of Knapp Draw would begin; and an overburden stockpile site (OSP-2, Figure 1.4-38) would be stripped of topsoil; haul roads would be developed to link these areas with the initial topsoil storage area; and topsoil stripping would begin over areas to be initially mined. In year 3, another overburden stockpile area (OSP-1) would be cleared of topsoil, and overburden removal would have commenced with the initial "boxcut" in the southwest corner of the South Block. By year 4, coal extraction would have begun and all mining operations would be advancing eastward through the South Block. In this year overburden backfilling would also begin in the sections first mined. Reclamation would begin on mined areas by year 6, and would closely follow mining activites until operations are terminated.

As the South Block nears completion in year 22, coal extraction would begin in the southwest corner of the North Block. Since this area would have been previously excavated in years 14, 15, and 16, a second boxcut would be avoided by leaving the adjacent pit only

Figure 1.4-38
Limits of Disturbance,
Rochelle Mine



partially filled, and temporarily revegetated. Overburden along the entire North Block-South Block interface would be handled a second time when the North Block is mined. Temporary reclamation measures form this area are outlined in Appendix A-1.

Because the North Block is approximately 2 miles wide, it would be split into 3 segments or "panels," oriented north-south, which would be mined consecutively, progressing as shown in Figure 1.4-38.

During the entire mining process, a total of six overburden stockpiles would be developed in prearranged locations, and would grow and shrink depending on the relationship between excavated material and the area immediately available for backfilling. This procedure is explained in more detail below.

Table 1.4-22 lists the major equipment that would be needed for mining and reclamation activities during the first 5 years of operation. The use of the manufacturer's name is for illustrative purposes only, and does not signify any intent to use these specific brands or models.

Topsoil Removal and Replacement. As discussed under mine construction, topsoil removed from pit areas in the initial years of mining would be stockpiled. As mining progresses, topsoil removed from a new portion of the pit would be immediately spread over mined out areas that have been backfilled with overburden (Figure 1.4-40).

Prior to removal, topsoil would be cleared of vegetation and recovery depth stakes would be set. The topsoil would generally be removed with self-loading scrapers and bulldozers. Where the material is of sufficient thickness and the A and B horizons are

partially filled, and temporarily revegetated. Overburden along the entire North Block-South Block interface would be backfilled a second time when the North Block is mined. Temporary reclamation measures for this area are outlined in Appendix A-1.

Because the North Block is approximately 2 miles wide, it would be split into 3 segments or "panels," released north-south, which would be mined consecutively, progressing as shown in Figure 1.4-3B.

During the entire mining process, a total of six overburden stockpiles would be developed in previously inverted, and would grow and shrink depending on the relationship between excavated material and the area immediately available for backfilling. This procedure is explained in more detail below.

Table 1.4-2C lists the major equipment that would be needed for mining and reclamation activities during the first 3 years of operation. The use of the equipment's name is for illustrative purposes only, and does not signify any intent to use those specific brands or models.

Topsoil Removal and Stockpiling. As discussed under mine construction, topsoil removal from pit areas in the Jurassic phase of mining would be accomplished. As mining progresses, topsoil removed from a new portion of the pit would be immediately spread over mined out areas that have been backfilled with overburden (Figure 1.4-4D).

Prior to removal, topsoil would be cleared of vegetation and temporary depth scales would be set. The topsoil would generally be removed with self-loading scrapers and bulldozers. Where the material is of sufficient thickness and the A and B horizons are

Deleted

Figure 1.4-39

TABLE 1.4-22

MINING AND RECLAMATION EQUIPMENT, ROCHELLE MINE
(Initial Five-Year Period)

Item	Maximum Number Required
Bucyrus Erie 295B Coal Shovels	2
Bucyrus Erie 295B Overburden Shovels	2
Robbins RR 11 Drills	2
Ingersoll-Rand D-5000 Drill	1
120-Ton Rear-Dump Coal Haulers	15
150-Ton Rear-Dump Overburden Haulers	10
D9 Tractor Dozers	4
Clark 300HP Rubber-Tire Dozers	3
12-16 yd Front-End Loader	1
25-30 yd Twin Engine Scrapers	3
Cat 16 Motor Graders (Patrol)	3
16,000 Gallon Water Trucks	2
100-Ton Tractor with Low Boy	1
Ford F-600 Utility Trucks	3
Ford LNT 800 & 8000 Service Trucks	3
Link Belt HG-238A Crane (140 Tons)	1
Light Duty Vehicles	21
Fork Lift (10 Ton)	1
Farm Tractor with Reclamation Equipment	1
Utility Tractor/Backhoe	1
Cherry Pickers (15 Ton & 35 Ton)	2

Note: Manufacturer designation is given only for size-type explanation; any item may be replaced by a comparable model at the time of purchase.

TABLE 1.4-1T

MINING AND RECLAMATION EQUIPMENT, MONTANA MINE
(Initial Five-Year Period)

Item	Minimum Number Required
Bucyrus Erie 1055 Coal Shovel	2
Bucyrus Erie 1055 Overburden Shovel	2
Bobcat AS 11 Drills	2
Ingersoll-Rand D-3000 Drill	1
120-Ton Rear-Dump Coal Haulers	13
150-Ton Rear-Dump Overburden Haulers	10
D9 Tractor Dozers	4
Clark 300BF Rubber-Tire Loaders	2
12-18 yd Front-End Loaders	1
25-30 yd Twin Engine Scrapers	2
Cat 16 Motor Graders (Paved)	3
15,000 Gallon Water Trucks	2
100-Ton Tractor with Low Bed	1
Ford F-500 Utility Trucks	2
Ford LNT 800 & 8000 Service Trucks	2
Link Belt TC-2124 Crane (100 Tons)	1
Light Duty Vehicles	31
Fork Lift (10 Ton)	1
Farm Tractor with Reclamation Equipment	2
Utility Tractor/Backhoe	2
Quarry Pickers (15 Ton & 25 Ton)	2

Note: Manufacturer designation is given only for size-type equipment; any item may be replaced by a comparable model at the time of purchase.

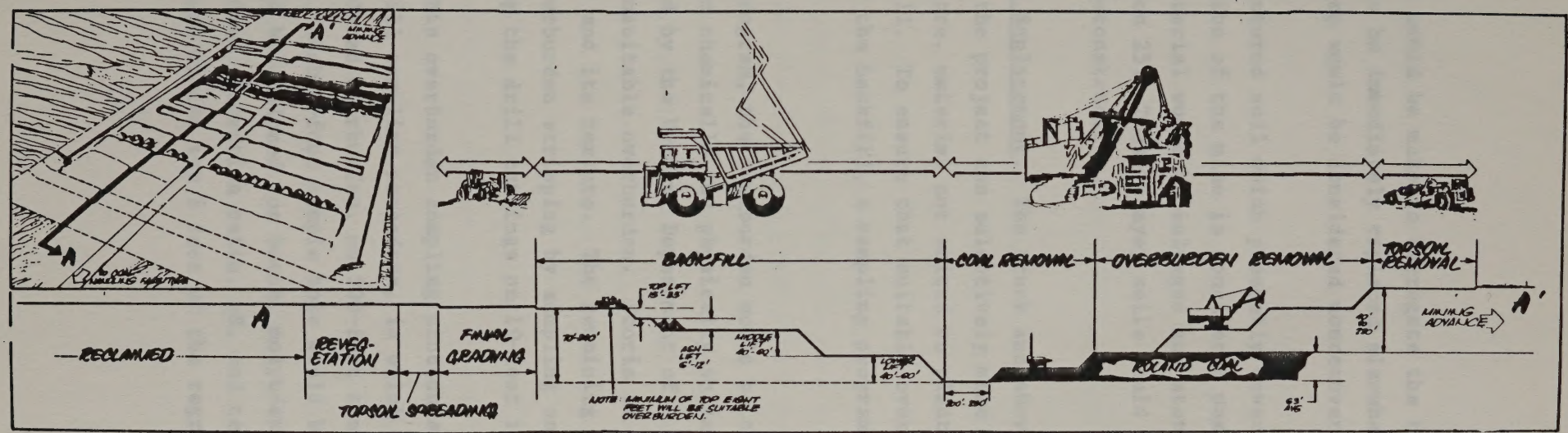


Figure 1.4-40 Typical Mining Sequence, Rochelle Mine (Schematic)

distinguishable, an attempt would be make to segregate the two horizons when the soil is to be immediately replaced elsewhere. Soils less than 6 inches deep would be considered nonrecoverable.

Although the clayey-textured soil which presently covers the playas in the northern portion of the mine is considered unsuitable as a growth medium, this material would be salvaged and stored in a separate stockpile in section 25. These clayey soils would be replaced as part of playa reconstruction.

Overburden Removal and Replacement. The truck and shovel mining method proposed for the project can selectively mine and place overburden material; therefore, material not suited to plant growth can be buried in the backfill. To ensure that suitable overburden is placed in the top 8 feet of the backfill, a sampling program would be maintained.

For purposes of this program, the overburden would be classified as either scoria; overburden chemically and physically suitable as a root-zone medium, as defined by the Wyoming Department of Environmental Quality; or unsuitable overburden. Scoria is easily recognized by its red color and its texture. The remaining overburden would be tested prior to overburden stripping by sampling one hole every 40 acres and analyzing the drill cuttings on 10-foot intervals.

The effectiveness of this overburden sampling procedure would in turn be assessed by a backfill sampling procedure, in which holes would be drilled in the replaced overburden, on 500-foot centers, just prior to topsoil placement. Each 8-foot sample hole would be split into two 4-foot intervals to be analyzed for boron, molybdenum, electrical conductivity, sodium absorption ratio, pH, and texture. If unsuitable overburden is found in the top 8 feet of the regraded soil,

the following steps would be taken:

- The area around the suspect hole would be sampled on a closer spacing;
- If the problem is related to pH, chemical amendments such as lime or fly ash would be added;
- The suspect area would be deep ripped and regraded; and,
- If none of the above solve the problem, the Wyoming Land Quality Division would be notified and an acceptable alternative procedure developed.

An adequate quantity of topsoil would be recovered to subsequently replace an average of 18 inches of soil over all areas disturbed by mining. Whenever possible, the organic-rich top layer would be replaced in the upper lift. Before topsoil is spread on a regraded area, the surface would be scarified by deep ripping along the contour, to minimize erosion and instability. Graders and farm equipment would be used to finish topsoil replacement; the redistributed topsoil would be reclaimed as outlined in Appendix A-1.

In some cases, it may be necessary to loosen the overburden by blasting. During full production, overburden blasting would be done approximately five times per week. ANFO, a mixture of pelletized ammonium nitrate and diesel oil, would be used for all overburden and coal blasting. ANFO would be prepared onsite and delivered to the blast area in trucks equipped for the purpose. Nonelectric detonating cord, which is moisture resistant and relatively insensitive to shock and friction, would be used with a single detonator cap for each blast.

the following steps would be taken:

- The area around the airport main would be sampled on a closer spacing;

- If the problem is related to pH, chemical amendments such as lime or fly ash would be added;

- The airport area would be deep ripped and replanted; and,

- If none of the above solve the problem, the Wyeis Land Quality Division would be notified and an acceptable alternative procedure developed.

An adequate quantity of topsoil would be retained to subsequently replace an average of 15 inches of soil over all areas disturbed by mining. Wherever possible, the concrete-like top layer would be replaced in the upper 12". Before topsoil is spread on a regraded area, the surface would be scarified by deep ripping along the contour, to minimize erosion and instability. Graders and farm equipment would be used to finish topsoil replacement; the redistributed topsoil would be vacuumed as outlined in Appendix A-1.

In some cases, it may be necessary to lessen the overburden by blasting. During full production, overburden blasting would be done approximately five times per week. ANFO, a mixture of pulverized ammonium nitrate and diesel oil, would be used for all overburden and coal blasting. ANFO would be prepared onsite and delivered to the blast area in trucks equipped for the purpose. Nonexplosive detonating cord, which is moisture resistant and relatively insensitive to shock and friction, would be used with a single detonator cap for each blast.

All blasting operations would be in compliance with local, state, and federal laws and regulations pertaining to the storage, handling, preparation, and use of explosives. In particular, the following regulations would be observed:

- Wyoming Department of Environmental Quality, Land Quality Division, Rules of Practice and Procedure, Chapter VI, "Blasting for Surface Coal Mining Operations."

- 30 CFR Sections 15, 16, 17, 55.6, and 77.1300 through 1308 (U.S. Mine Safety and Health Administration regulations).

- 27 CFR Part 181, "Commerce in Explosives," by the Bureau of Alcohol, Tobacco Products and Firearms of the U.S. Department of the Treasury.

Following blasting, overburden would usually be loaded by 20-yd^3 electric-powered shovels into 150-ton capacity diesel-powered haulers. When overburden cannot be used immediately to backfill mined out portions of the pit, it would be stored in one of six overburden stockpiles (Figure 1.4-41).

Whenever practical, overburden would be hauled directly from one end of the pit to the other, and dumped in several lifts. A distance of at least 200 feet would separate the active coal face and the lowest backfill lift. Although the number and height of these lifts would vary with conditions, specific requirements apply to two of them:

- The top lift would be composed of suitable overburden material (as defined previously), to a minimum depth of 8

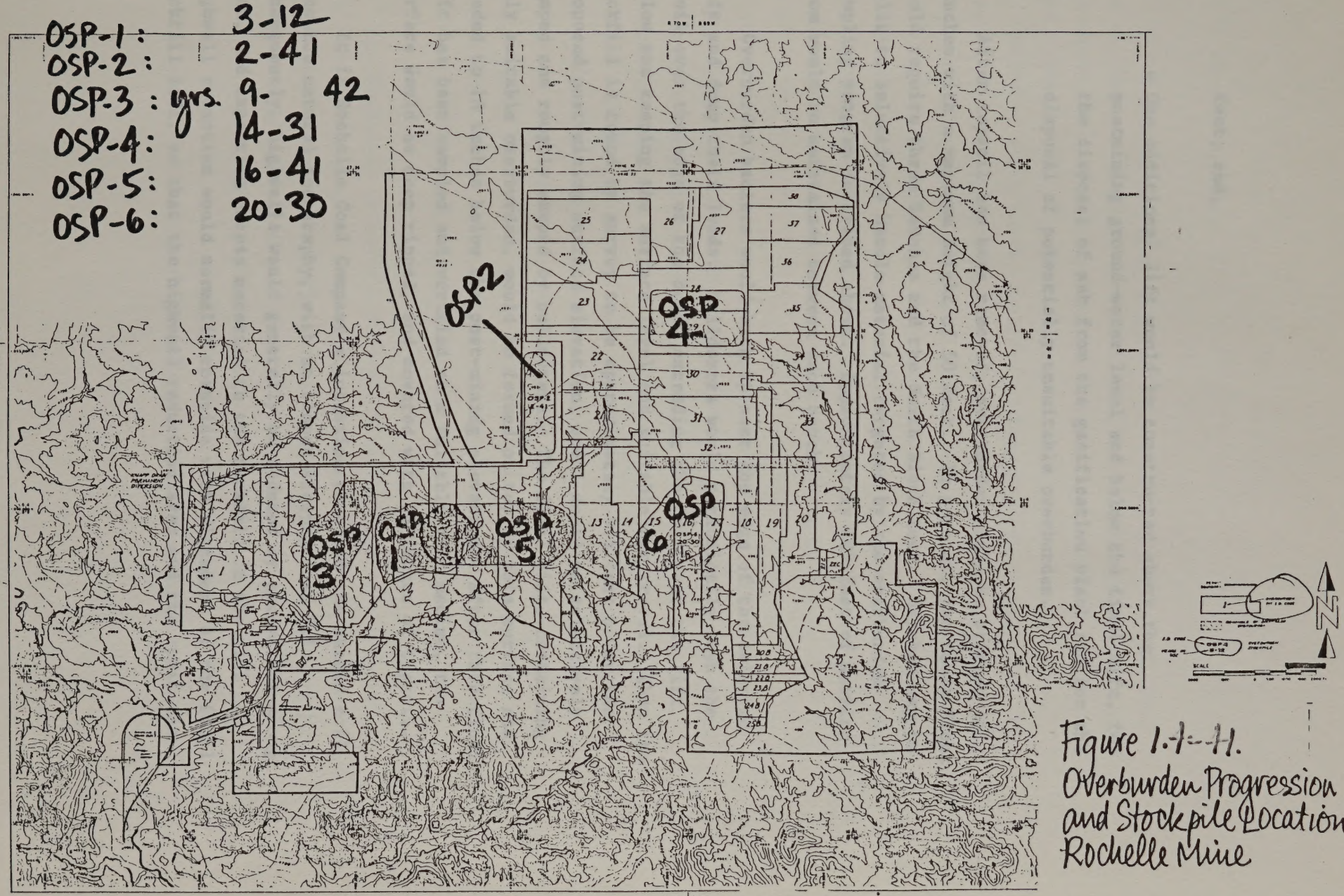


Figure 1.1-11.
Overburden Progression and Stockpile Location, Rochelle Mine

feet; and,

- One additional lift would be constructed above the postmining ground-water level and below the final lift, for the disposal of ash from the gasification plant and for the disposal of potentially unsuitable overburden.

After topsoil has been removed, overburden would be stripped in benches with a maximum height of 50 feet. In general, the South Block would require three benches and the North Block four. Benches may be split to selectively handle material targeted by the overburden sampling program described above. Approximately 225 feet of working room would be maintained between each bench.

Overburden haulers would back up near the edge of the selected lift and dump their loads. Bulldozers would periodically push the spoil over the edge of the dump, extending the fill over the lift below and keeping the surface level and suitable for travel. When the backfill is found by survey to be approximately 9.5 feet below the proposed post-mining surface elevation, spoil would be selectively dumped and roughly shaped by bulldozers. The final lift, containing only suitable overburden, would be formed on top of this surface and graded to 18 inches below the post-mining elevation. After this final lift has been sampled and verified as a suitable root medium, the surface would be deep ripped, and covered with 18 inches of topsoil.

It is Rochelle Coal Company's intention to blend the shaped soil into the natural topography, with no slopes steeper than 5:1. Consequently, highwalls would generally be reduced by excavating along them, and exporting excess material to the backfill in the pit. Highwall reduction would normally coincide with placement of the final backfill lift, so that the highwall reduction area and the spoil can

feet; and,

- One additional lift could be constructed above the penstocking ground-water level and below the final lift, for the disposal of ash from the pulverizing plant and for the disposal of potentially unstable overburden.

After topsoil has been removed, overburden would be stripped to benches with a maximum height of 30 feet. In general, the final pit would require three benches and the North Block Pit. Benches may be split to selectively handle materials targeted by the overburden sampling program described above. Approximately 125 feet of working room would be maintained between each bench.

Overburden haulers would back up near the edge of the exposed lift and dump their loads. Bulldozers would periodically push the spoil over the edge of the dump, uncovering the fill over the lift below and keeping the surface level and suitable for haulage. When the backfill is found by survey to be approximately 8.5 feet below the proposed post-mining surface elevation, spoil would be selectively dumped and roughly shaped by bulldozers. The final lift, containing only suitable overburden, would be formed as top of fill surface and graded to 18 inches below the post-mining elevation. After this final lift has been sampled and verified as a suitable root medium, the surface would be deep ripped, and covered with 18 inches of topsoil.

It is Rochelle Coal Company's intention to blend the coarse fill into the natural topography, with no slopes steeper than 3:1. Consequently, highwalls would generally be reduced by excavating along them, and exposing excess material to the backfill in the pit. Highwall reduction would normally coincide with placement of the final backfill lift, so that the highwall reduction area and the spoil can

be reshaped as a unit.

Coal Removal and Handling. Following overburden removal, the top of the coal would be cleaned of waste, and drilled and blasted as described above. Coal blasting would occur approximately 10 times a week. Shovels would load the fractured coal into 120-ton rear-dump coal haulers, which would transport it from the pit to the dump hopper. Because of the thickness of the Roland coal seam, these steps would take place on two benches, equal in height. The upper bench would precede the lower one by approximately 200 feet. The coal would be hauled out of the pits in the South Block via a center ramp through the backfill. In the North Block, coal would be routed through end openings maintained between the panels of the block.

Coal hauled from the mine would be dumped into a 90-foot-deep hopper (Figure 1.4-36). The coal would then be fed through crushers to reduce it to 3 inches in size. Crushed coal would move by a 72-inch-wide conveyor, 3,200 feet to one of 5 storage silos having a combined capacity of 75,000 tons. The silos would be linked to a loadout facility on the railroad loop by two 72-inch-wide, 2,500-foot-long conveyors. When railroad cars are being loaded, the coal would be gravity fed onto the conveyor and into a weigh bin over the tracks. Before coal is discharged into individual cars, it would be automatically sampled and weighed.

Ash Disposal. Because the permit area is relatively flat and well above the predicted post-mining ground-water level, it would provide a location for the disposal of fly ash, gasifier ash, and FGD sludge from the proposed gasification plant. This ash is not considered hazardour by RCRA standards.

Because of the ash's water content and the consequent difficulty

be reshaped as a unit.

Coal Removal and Handling. Following overburden removal, the top of the coal would be cleaned of rocks, and drilled and blasted as described above. Coal blasting would occur approximately 15 times a week. Shovels would load the fractured coal into 150-ton rear-dump coal haulers, which would transport it from the pit to the dump hopper. Because of the thickness of the Eocene coal seam, three lifts would take place on two benches, approx. 70 height. The upper bench would precede the lower one by approximately 300 feet. The coal would be hauled out of the pits in the Eocene Sheet via a ramp through the backfill. In the Hart Sheet, coal would be hauled through the openings maintained between the nodule of the block.

Coal hauled from the pits would be dumped into a 50-foot-deep hopper (Figure I.4-38). The coal would then be fed through crushers to reduce it to 2 inches in size. Crushed coal would move by a 72-inch-wide conveyor, 3,200 feet to one of 3 silos either having a combined capacity of 75,000 tons. The silos would be linked to a loadout facility on the railroad loop by two 72-inch-wide, 2,350-foot-long conveyors. When railroad cars are being loaded, the coal would be gravity fed onto the conveyor and into a weigh bin over the tracks. Before coal is discharged into individual cars, it would be automatically sampled and weighed.

Ash Disposal. Because the project area is relatively flat and well above the predicted post-mining ground-water level, it would provide a location for the disposal of fly ash, gasifier ash, and FGD sludge from the proposed gasification plant. This ash is not classified hazardous by RCRA standards.

Because of the small water courses and the concomitant difficulty

of handling it in below-freezing weather, regular ash deliveries to the mine would only be made in warm weather. Ash would arrive in cars designated to this purpose and be emptied into a dump hopper beneath the railroad loop. A conveyor would carry the ash to a silo near the coal dump hopper, where it would be loaded into empty coal haulers for delivery to the pit backfill area.

The proposed disposal method would be to dump the ash at the bottom of the top backfill lift. The ash depth at dumping locations would average five to seven feet. Because the backfill lift would continue to advance when no ash was being dumped, the ash locations would be randomly discontinuous. Because ash would be delivered only during warm weather, backfill efforts would be concentrated on lower lifts during cold weather, leaving a broad upper bench area for ash disposal. Ash disposal would not occur beneath the 100-year floodplain of any drainage in the proposed post-mining topography, nor beneath reconstructed playas or other recharge areas.

The areal extent, depth, and location of all ash deposits would be reported annually to the Solid Waste Division of the Wyoming Department of Environmental Quality.

Pit Dewatering. The mining pit would be dewatered by means of pumps sized to handle, without interruption of normal mining activities, a maximum inflow equal to 35 gpm plus the precipitation from a 10-year, 24-hour rainstorm. Under normal mining conditions, water would collect in low areas or in sumps, from which it would be pumped to Reservoir SP-1 (Figure 1.4-37). Water collected in this reservoir would be clarified and discharged into Red Draw. Some of the water may be used for dust suppression.

Energy and Water Requirements. Space heaters, power shovels, and

conveyors would be electrically operated. Power would be provided by a local utility. In a typical year of full production, the mine would require 33.5 mW of electricity.

Approximately 3.1 million gallons of diesel fuel (No. 2) would be used at the mine each year during full production. Approximately 180,000 gallons per year of gasoline would also be used during mine operation.

Mine operation would require an estimated 229,200 gallons per day of water. This water would be obtained from a single deep well.

Mine Wastes. Construction waste components and disposal plans would be as follows:

- Human waste: contractor-maintained portable toilets
- Solid construction waste: permitted landfill
- Storm runoff: NPDES-approved settling ponds and discharge points
- Settling pond sediment: post-construction burial.

Discharge would be intermittent, and there would be no heated effluents.

The operational waste stream and disposal plans would be as follows:

- Human waste: permitted sewage lagoon

- Solid waste: permitted landfill

- Spent oil and solvents: recycled

- Storm runoff: NPDES-approved settling ponds and discharge points

- Settling pond sediment: burial with mine spoil at approximately one-year intervals.

Discharge would be intermittent, with no heated effluents.

1.5 AUTHORIZING ACTIONS

Major federal, state, and local approvals associated with environmental concerns that would have to be obtained before the proposed action could be implemented are presented below.

Federal

Bureau of Land Management (BLM). The BLM Wyoming State Office is responsible for the preparation of the environmental impact statement and for the issuance of grants of right-of-way (ROW) across lands under its jurisdiction. The ROW grants would be issued under the authority of Title V of the Federal Land Management Policy Act (FLPMA), as defined in 43 CFR 2800. WyCoalGas has submitted applications for two right-of-way permits, serial numbers W47428 and W64644.

Temporary use permits for additional construction space, storage sites, major drainage crossings, highway and railroad crossings, and other utility crossings would be issued from the appropriate BLM district office under the authority of Title V of FLPMA, as defined in 43 CFR 2920.

The BLM is also responsible for the issuance of an undetermined number of noncompetitive (negotiated) sales of mineral material (commercial fill, sand, and gravel, and other surfacing or construction material of common variety) under 43 CFR 3611, Noncompetitive Sales.

Office of Surface Mining (OSM). Under the Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87), the coal mining and reclamation plan will be reviewed by OSM and the Wyoming Department of Environmental Quality (DEQ). Under the authority of the Mineral Leasing Act, as amended, the OSM approves or recommends coal mining actions on federal lands.

Geological Survey (USGS). Development, production, and coal resource recovery requirements in the mining permit are approved by USGS as stipulated in the Mineral Leasing Requirements of 1920, amended 1976 by the Federal Coal Leasing Act of 1978, and 30 CFR 211.

Fish and Wildlife Service (FWS). The FWS is responsible for providing consultation to the BLM concerning the possible effects of the proposed action on fish and wildlife as required by Section 10 of the Wildlife Coordination Act; Section 7 of the Endangered Species Act of 1973, as amended; the Migratory Bird Treaty Act (Sec. 3, 40 Statute 755, 16 USC 704); the Bald Eagle Act of 1940 (Title 54, Statute 250); and the Wild Horse and Burro Act (P.L. 92-195). Consultation on threatened and endangered species will be initiated and conducted in accordance with 50 CFR 402, Interagency Cooperation, Endangered Species Act of 1973.

Forest Service (FS). In accordance with Title V of FLPMA as defined in 36 CFR 251, the Forest Service is responsible for issuing a special use permit for approximately 4.5 miles of the electric railroad right-of-way that would cross the Thunder Basin National Grassland. Temporary use permits for mineral materials (e.g., fill, sand, and gravel) and for storage or overstripping are issued by the FS. The Forest Service must also review the coal mine and reclamation plan and consent to permit issuance prior to OSM and state approval as defined in 30 CFR 741.

Federal Energy Regulatory Commission (FERC). Under Section 7 of the Natural Gas Act, FERC has the authority to issue or deny a Certificate of Public Convenience and Necessity prior to the interstate sale and/or transportation of natural gas. The issuance of the certificate is dependent on customer service needs, project

financing, and design feasibility.

Army Corps of Engineers (COE). Under Section 404 of the Clean Water Act of 1977 (40 CFR 122-123), implemented by COE regulations (33 CFR 323), construction of the intake structure on the North Platte River and all river and stream crossings would be permitted under the nationwide permit for utility lines (33 CFR 323), provided that the conditions of this permit are met. However, the Corps does have discretionary authority to require individual permits for some or all pipeline crossings if the District Engineer determines that the concerns of the aquatic environment indicate a need for such action (33 CFR 323.4-4).

Environmental Protection Agency (EPA). EPA's regulatory authority over the proposed project would be based on regulations implementing the Resource Conservation and Recovery Act (RCRA) of 1976. EPA has given authority for the state to administer federal air and water regulations.

Advisory Council on Historic Preservation (ACHP). Section 106 of the Historic Preservation Act of 1966, as amended, requires that the President's Advisory Council on Historic Preservation have an opportunity to comment on any undertaking that affects cultural resources listed in or eligible for the National Register of Historic Places. Executive Order 11593 (Protection and Enhancement of the Cultural Environment) mandates that all executive branch agencies, bureaus, and offices (1) compile an inventory of the cultural resources for which they are trustee; (2) nominate all eligible government properties to the National Register of Historic Places; (3) preserve and protect their cultural resources; and (4) ensure that agency activities contribute to the preservation and protection of non-federally-owned cultural resources. The Advisory Council implements

financing, and design feasibility.

Army Corps of Engineers (COE). Under Section 404 of the Clean Water Act of 1977 (40 CFR 122-124), implemented by COE regulations (33 CFR 323), construction of the Lewis structures on the Black River Water and all river and stream crossings would be permitted under the nationwide permit for utility lines (33 CFR 323), provided that the conditions of this permit are met. However, the Corps does have discretionary authority to require individual permits for some or all pipeline crossings if the District Engineer determines that the concerns of the aquatic environment justify a need for such action (33 CFR 323.4-4).

Environmental Protection Agency (EPA). EPA's regulatory authority over the proposed project would be based on regulations implementing the Resource Conservation and Recovery Act (RCRA) of 1976. EPA has given authority for the state to administer federal air and water regulations.

Advisory Council on Historic Preservation (ACHP). Section 106 of the Historic Preservation Act of 1966, as amended, requires that the President's Advisory Council on Historic Preservation have an opportunity to comment on any undertaking that affects cultural resources listed in or eligible for the National Register of Historic Places. Executive Order 11593 (Protection and Enhancement of the Cultural Environment) mandates that all cooperative Federal agencies, bureaus, and offices (1) compile an inventory of the cultural resources for which they are responsible; (2) coordinate all activities involving properties in the National Register of Historic Places; (3) preserve and protect their cultural resources; and (4) ensure that agency activities contribute to the preservation and protection of non-federally-owned cultural resources. The Advisory Council implements

these regulations through the process outlined in 36 CFR 800 (Protection of Historic and Cultural Properties).

State

Wyoming Industrial Siting Council. Under the Industrial Development Information and Siting Act of 1975 (Wyoming Statute 35-12-101), a Wyoming Industrial Siting Act permit must be obtained for construction of all project components except the mine.

Wyoming Department of Environmental Quality (DEQ), Air Quality Division. The Air Quality Division administers and enforces federal Prevention of Significant Deterioration (PSD) regulations, ambient air quality standards, federal visibility regulations and state air quality regulations. Under Section 21 of the Wyoming Air Quality Standards and Regulations, air quality permits are required for the construction and operation of the proposed project.

DEQ Water Quality Division. Under Wyoming statutes 35-11-301 (a.i) and 35-11-301 (a.iii), the Wyoming Water Quality Division issues a National Pollutant Discharge Elimination System (NPDES) permit to construct, install, or modify public water supplies and waste water facilities.

DEQLand Quality Division. This division, with the approval of OSM, regulates surface coal mining and reclamation activities under the Surface Mining Control and Reclamation Act of 1977, the Wyoming Environmental Quality Act of 1973, as amended, and the Land Quality Rules and Regulations of 1980.

Solid Waste Program. Approval of waste disposal facilities must be obtained from the solid waste management supervisor, in accordance with Wyoming Statute 35-11-502.

same regulations through the process outlined in 35 CFR 800 (Protection of Historic and Cultural Properties).

States

Wyoming Industrial Siting Council. Under the Industrial Development Information and Siting Act of 1973 (Wyoming Statutes 35-12-101), a Wyoming Industrial Siting Act permit must be obtained for construction of all project components except the mine.

Wyoming Department of Environmental Quality (DEQ), Air Quality Division. The Air Quality Division administers and enforces federal requirements of significant deterioration (PSD) regulations, ambient air quality standards, federal visibility requirements and toxic air quality regulations. Under Section 21 of the Wyoming Air Quality Standards and Regulations, air quality permits are required for the construction and operation of the proposed project.

DEQ Water Quality Division. Under Wyoming statutes 35-11-301 (a.ii) and 35-11-301 (a.iii), the Wyoming Water Quality Division issues a National Pollutant Discharge Elimination System (NPDES) permit to construct, install, or modify public water supplies and waste water facilities.

DEQ/Land Quality Division. This division, with the approval of OSM, regulates surface coal mining and reclamation activities under the Surface Mining Control and Reclamation Act of 1977, the Wyoming Environmental Quality Act of 1973, as amended, and the Land Quality Rules and Regulations of 1980.

Solid Waste Program. Approval of waste disposal facilities must be obtained from the solid waste management supervisor, in accordance with Wyoming Statute 35-11-506.

Wyoming Board of Control/State Engineer. Under Wyoming Statutes 41-3-301, 41-3-905, and 41-4-501, the Wyoming State Engineer is responsible for issuing permits for appropriation of surface water and ground water and for constructing a dam or reservoir to impound or store water.

Wyoming State Highway Commission. Permits must be obtained from the Wyoming Highway Commission to cross state roads. The Highway Commission is also responsible for issuing a utility license to conduct construction activities in a highway right-of-way.

Wyoming State Historic Preservation Office (SHPO). As stipulated in the National Historic Preservation Act of 1966 as amended, EO 115.93, 36 CFR 60, 36 CFR 800, and 36 CFR 1213, consultation with the SHPO is required on matters affecting historical and archeological resources.

Colorado State Highway Commission. Permits must be obtained from the Colorado Highway Commission to cross state roads.

Other Jurisdictions

WyCoalGas is responsible for identifying and applying for special use and other permits from local and regional districts and jurisdictions. Permits may be needed from authorities such as irrigation and water conservation districts, drainage districts, and counties. Other jurisdictions would be responsible for issuing easements and permits as appropriate.

Wyoming Board of Conservation Districts. Under Wyoming Statutes 41-3-201, 41-3-203, and 41-4-301, the Wyoming State Engineer is responsible for issuing permits for appropriation of surface water and ground water and for constructing a dam or reservoir to impound or store water.

Wyoming State Highway Commission. Footwater must be obtained from the Wyoming Highway Commission to cross state roads. The Highway Commission is also responsible for issuing a utility license to conduct construction activities in a highway right-of-way.

Wyoming State Historic Preservation Office (SHPO). As stipulated in the National Historic Preservation Act of 1966 as amended, 36 CFR 60, 36 CFR 63, 36 CFR 800, and 36 CFR 1012, consultation with the SHPO is required on matters affecting historical and archaeological resources.

Colorado State Highway Commission. Footwater must be obtained from the Colorado Highway Commission on some state roads.

Other Jurisdictions

Wyoming is responsible for identifying and applying for special use and other permits from local and regional districts and jurisdictions. Permits may be needed from authorities such as irrigation and water conservation districts, drainage districts, and counties. Other jurisdictions would be responsible for issuing easements and permits as appropriate.

1.6 INTERRELATIONSHIPS OF PROPOSED ACTION WITH OTHER PLANNED PROJECTS

Existing and future private energy- and resource-related projects whose areas of influence may overlap with that of the proposed project were considered in this EIS (Tables 1.6-1 and 1.6-2). Figures 1.6-1 and 1.6-2 show the locations of these projects.

For purposes of this EIS, a future project is defined as a project that would begin operation in 1981 or later if it is initiated. This definition includes projects which have been constructed but have had operation postponed or suspended until 1981 or later.

The economic base of Campbell County is dominated by the coal industry. Projections of future coal development in the county show a greater than threefold increase in production by 1995 if currently reported plans are realized.

Baseline forecasts of economic activity in Converse County include stable growth in oil and gas development until 1990; implementation of NERCO's Antelope Coal Mine and PRLA coal mines; and a rapid decline in uranium mining and milling.

1.7 ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed action that have been considered for this environmental assessment are listed in Table 1.7-1. Many of these alternatives were identified by WyCoalGas during the conceptual development and preliminary design of the proposed action. Others were identified through the public scoping process and interagency coordination. Finally, alternatives were identified by those (see Section 4.3 of the EIS) who participated in the preparation of this

TABLE 1.6-1

EXISTING[a] ENERGY AND RESOURCE RELATED PROJECTS IN THE VICINITY OF THE PROPOSED PROJECT

Project Name	Company	Location[b]	County	Project	Map Reference[c]
Dave Johnston Power Plant	Pacific Power and Light	T. 34 N., R. 76 W. (6 mi. east of Glenrock)	Converse	Power Plant	1
Laramie River Station	Missouri Basin Power Project	T. 25 N., R. 67 W. (5 mi. northeast of Wheatland)	Platte	Power Plant	2
Neil Simpson Power Plant	Black Hills Power & Light	T. 50 N., R. 71 W. (7 mi. east of Gillette)	Campbell	Power Plant	3
Osage Power Plant	Black Hills Power & Light	T. 46 N., R. 63 W. (Osage)	Weston	Power Plant	4
Wyodak Power Plant	Pacific Power and Light	T. 50 N., R. 71 W. (7 mi. east of Gillette)	Campbell	Power Plant	5
Amoco Refinery	Amoco Oil Company	T. 33 N., R. 79 W. (Casper)	Natrona	Petroleum Refinery	6
C & H Refinery	C & H Refinery	T. 32 N., R. 63 W. (Lusk)	Niobrara	Petroleum Refinery	7
Glenrock Refinery	Glenrock Refinery, Inc.	(Glenrock)	Converse	Petroleum Refinery	8
Little America Refinery	Little America Refinery Co.	T. 34 N., R. 78 W. (Casper)	Natrona	Petroleum Refinery	9
Osage Refinery	Glacier Park Co. (Burlington Northern, Inc.)	T. 46 N., R. 63 W. (Osage)	Weston	Petroleum Refinery	10
Texaco Refinery	Texaco, Inc.	T. 34 N., R. 79 W. (Casper)	Natrona	Petroleum Refinery	11
Wyoming Refinery Company Petroleum Refinery	Hamilton Bros. Petroleum	T. 45 N., R. 61 W. (Newcastle)	Weston	Petroleum Refinery	12
Bear Creek Mine and Mill	Bear Creek Uranium Co. (Rocky Mountain Energy)	T. 38 N., R. 73 W. (Northeast of Glenrock)	Converse	Surface Uranium Mine and Mill	13
Highland Mine and Mill	Exxon Minerals Company	T. 36 N., R. 72 W. (23 mi. northwest of Douglas)	Converse	Combination Surface Underground Uranium Mine and Mill	14
Irigaray	Wyoming Minerals Corporation	T. 45 N., R. 77 W. (55 mi. southeast of Buffalo)	Johnson	In Situ Uranium Mine	15
Belle Ayr Mine	Amax Coal Company	T. 48 N., R. 71 W. (18 mi. southeast of Gillette)	Campbell	Coal Strip Mine	16
Big Horn Strip Mine	Peter Kiewit and Sons	T. 57 N., R. 84 W. (8 mi. north of Sheridan)	Sheridan	Coal Strip Mine	17
Black Thunder Mine	Thunder Basin Coal Co. (ARCO)	T. 43 N., R. 70 W. (48 mi. southeast of Gillette)	Campbell	Coal Strip Mine	18
Caballo Mine	Carter-Exxon	T. 48 N., R. 70 W. and 71 W. (17 mi. south of Gillette)	Campbell	Coal Strip Mine	19
Clovis Point Mine	Kerr-McGee	T. 50 N., R. 71 W. (4 mi. east of Gillette)	Campbell	Coal Strip Mine	20
Cordero Strip Mine	Cordero Mining Company	T. 47 N., R. 71 W. (22 mi. south of Gillette)	Campbell	Coal Strip Mine	21
Dave Johnston Mine	Glenrock Coal Company (NERCO)	T. 36 N., R. 75 W. (14 mi. north of Glenrock)	Converse	Coal Strip Mine	22

TABLE 1.6-1 Concluded

Project Name	Company	Location[b]	County	Project	Map Reference[c]
Eagle Butte Mine	Amax	T. 51 N., R. 72 W. (6 mi. north of Gillette)	Campbell	Coal Strip Mine	23
Fort Union Mine	Fort Union Mine Partnership	T. 51 N., R. 71 W. (7 mi. northeast of Gillette)	Campbell	Coal Strip Mine	24
Jacobs Ranch Mine	Kerr-McGee	T. 43 N., R. 70 W. (50 mi. southeast of Gillette)	Campbell	Coal Strip Mine	25
Rawhide Mine	Carter-Exxon	T. 51 N., R. 72 and 73 W., T. 52 N., R. 72 W. (8 mi. north of Gillette)	Campbell	Coal Strip Mine	26
Wyodak Mine	Black Hills Power & Light	T. 50 N., R. 71 W. (7 mi. east of Gillette)	Campbell	Coal Strip Mine	27
Benton Clay	Benton Clay Co.	T. 45 N., R. 82 W. (Mayoworth)	Johnson	Bentonite Mine	28
Bentonite Mill	Benton Clay Co.	(Mills)	Natrona	Bentonite Mine and Mill	29
Bentonite Mine and Mill	American Colloid Company	T. 58 N., R. 64 W. (Northeast corner of Crook County)	Crook	Bentonite Mine and Mill	30
Bentonite Mine and Mill	International Minerals and Chemical Corporation	(Northeast corner of Crook County)	Crook	Bentonite Mine and Mill	31
Bentonite Mine and Mill	NL Industries - Bariod Petroleum Services	(Northeast corner of Crook County)	Crook	Bentonite Mine and Mill	32
Colony Plant Mine and Mill	Federal Bentonite Company	(Colony)	Crook	Bentonite Mine and Mill	33
Kaycee Bentonite Mine	Kaycee Bentonite Corporation	T. 44 N., R. 82 W. (Outside of Kaycee)	Johnson	Bentonite Mine	34
Kaycee Mill	Kaycee Bentonite Corporation	T. 33 N., R. 79 W. (Mills)	Natrona	Bentonite Mill	35
Upton Bentonite Mine	American Colloid Corporation	T. 48 N., R. 65 W. (North of Upton)	Weston	Bentonite Mine and Mill	36
Upton Bentonite Mine and Mill	Federal Bentonite Division	T. 48 N., R. 65 W. (3 mi. northwest of Upton)	Weston	Bentonite Mine and Mill	37
Guernsey Railroad Yard	Burlington Northern	(Guernsey)	Platte	Railroad Yard	38

Sources: Wyoming State Office, U.S. Bureau of Land Management; Wyoming Department of Economic Planning and Development, Mineral Development Monitoring System, revised March 1981.

[a]"Existing" projects are defined as those with productive operations underway prior to 1981.
[b]When project encompasses more than one township and range, given location is that of central facility or office.
[c]See Figure 6.2-1.

Table 1.2.2: [illegible]

Project Name	Company	Location[a]	Country	Project Type	Net Capacity (MW)
Eagle Mountain Mine	Dunn	[illegible]	Canada	Coal [illegible] Mine	[illegible]
Fort Union Mine	Fort Union Mine Partnership	[illegible]	Canada	Coal [illegible] Mine	[illegible]
Jacobs Ranch Mine	Burlington	[illegible]	Canada	Coal Strip Mine	[illegible]
Genesis Mine	Sunset-Black	[illegible]	Canada	Coal Strip Mine	[illegible]
Hycrest Mine	Final Mills Fraser & Leigh	[illegible]	Canada	Gas Strip Mine	[illegible]
Bowen Clay	Bowen Clay Co.	[illegible]	Germany	Bituminous Strip Mine	[illegible]
Bernstein Mill	Bernstein Clay Co.	[illegible]	Germany	Bituminous Strip Mine	[illegible]
Bituminite Mine and Mill	Bituminite Refining Company	[illegible]	France	Bituminite Strip Mine and Mill	[illegible]
Bituminite Mine and Mill	International Bituminite and Kimmeridge Oil Corporation	[illegible]	France	Bituminite Strip Mine and Mill	[illegible]
Bituminite Mine and Mill	Bituminite - Oil Corporation Bituminite Refining Company	[illegible]	France	Bituminite Strip Mine and Mill	[illegible]
Oolite Flow Mine and Mill	Fossil Bituminite Company	[illegible]	France	Bituminite Strip Mine and Mill	[illegible]
Lignite Coating in Mine	Kraftwerk Lignite Corporation	[illegible]	Germany	Bituminite Strip Mine	[illegible]
Tarsus Mill	Bituminite Corporation	[illegible]	Germany	Bituminite Mill	[illegible]
Lying Bituminite Mine	Bituminite Refining Company	[illegible]	France	Bituminite Strip Mine	[illegible]
Bituminite Mine and Mill	Fossil Bituminite Corporation	[illegible]	Spain	Bituminite Strip Mine and Mill	[illegible]
Bituminite Slate Pit	Petrolgrin Brandum	[illegible]	Africa	Bituminite Pit	[illegible]

Sources: Energy Data Office, U.S. Bureau of Mines Geographic Mineral Commodities at Energy Planning and Development, Energy Resources Commission, Sacramento, California, 1977.

[a] "Location" coordinates are defined as [illegible] Geological Survey coordinates [illegible] "Mine Location Geographical Data Sheet" [illegible] in [illegible] of [illegible] Mine [illegible] Mine.

See Figure 2.2-1.

TABLE 1.6-2

FUTURE[a] ENERGY AND RESOURCE RELATED PROJECTS IN THE VICINITY OF THE PROPOSED PROJECT

Project Name	Company	Location[f]	County	Project	Proposed Schedule Initial Construction	Proposed Schedule Initial Production	Map Reference[g]
Antelope Coal Mine	Antelope Coal Co. (NERCO, Inc.)	T. 40 N., R. 70 W. (50 miles north of Douglas)	Converse	Surface Coal Mine	1982	1984	1
Buckskin Mine	Shell Oil Co.	T. 51 N., R. 72 W. (10 miles north of Gillette)	Campbell	Surface Coal Mine	1980	1981	2
Coal Creek Mine	Thunder Basin Coal Co. (ARCO)	T. 46 N., R. 70 W. (30 miles southeast of Gillette)	Campbell	Surface Coal Mine	1980	1982	3
Dry Fork Mine	Cities Service	T. 57 N., R. 71 W. (45 miles north-northeast of Gillette)	Campbell	Surface Coal Mine	1983	1985	4
Dutchman Mine	JMT Co. (Great Plains Resources and Development Co.)	T. 55 N., R. 82 W. (13 miles east-southeast of Sheridan)	Sheridan	Surface Coal Mine	Unknown[b]		5
East Gillette Mine	Kerr-McGee	T. 50 N., R. 71 W. (4 miles east of Gillette)	Campbell	Surface Coal Mine	1982	1984	6
North Antelope Mine	North Antelope Coal Company (Peabody Coal Co.)	T. 41 N., R. 70 W. (55 miles north-northeast of Douglas)	Campbell	Surface Coal Mine	1981	1984	7
Nortn Rochelle Mine	Shell Oil Company	T. 42 N., R. 70 W. (10 miles southeast of Wright)	Campbell	Surface Coal Mine	1983	1985	8
Pronghorn Mine	Mobil Oil Company	T. 47 N., R. 71 W. (20 miles south-southeast of Gillette)	Campbell	Surface Coal Mine	1981	1982	9
Rawhide South Mine	Carter Mining Company (Exxon)	T. 50 N., R. 71 W. and R. 72 W. (5 miles northeast of Gillette)	Campbell	Surface Coal Mine	1981	1983	10
Rojo Caballos Mine	Mobil Oil Company	T. 47 N., R. 71 W. (20 miles south-southeast of Gillette)	Campbell	Surface Coal Mine	1981	1983	11
Wildcat Creek Mine	Pittsburg Midway Coal Company (Gulf Oil)	T. 52 N., R. 73 W. (16 miles northwest of Gillette)	Campbell	Surface Coal Mine	1981	1983	12
Wymo Fuels Mine	Wymo Fuels, Inc.	T. 45 N., R. 70 W. (30 miles south-southeast of Gillette)	Campbell	Surface Coal Mine	1982	1984	13
Campbell County PRLAs					1987	1988	
Belle Fourche	Wold Nuclear		Campbell	Surface Coal Mine			14
East Black Thunder	ARCO		Campbell	Surface Coal Mine			15
South Gillette	Peabody Coal		Campbell	Surface Coal Mine			16
Thunderbird Project	El Paso Energy Resources		Campbell and Johnson	Surface Coal Mine			17
Thunderbird II	Wold and Jenkins		Campbell and Johnson	In Situ Coal Mine			18
Wildcat Creek Area	Consolidation Coal Co.	(North of Gillette)	Campbell	Surface Coal Mine			19
Converse County PRLAs					1990	1992	
Dull Center	Peabody Coal Co.		Converse	Surface Coal Mine			20
Sand Draw	Peabody Coal Co.		Converse	Surface Coal Mine			21
South Antelope	Peabody Coal Co.		Converse	Surface Coal Mine			22
South Powder River	Dixie		Converse	Surface and Underground Coal Mines			23
Stevens North	Western Fuels		Converse	Surface Coal Mine			24
Stevens South	Western Fuels		Converse	Underground Coal Mine			25
Sheridan County PRLA Ulm Project Block	Woodson Oil Properties	(Southeast of Sheridan)	Sheridan	Surface Coal Mine	1988	1990	26

[illegible]

TABLE 1.6-2 Concluded

Project Name	Company	Location[f]	County	Project	Proposed Schedule Initial Construction	Proposed Schedule Initial Production	Map Reference[g]
Bill Smith Mine	Kerr-McGee Nuclear Corp.	T. 36 N., R. 74 W. (Northwest of Douglas)	Converse	Underground Uranium Mine	1980[c]	1986[c]	27
Charlie Ore Body	Cotter Corporation (Commonwealth Edison)	T. 45 N., R. 77 W. (Pumpkin Buttes)	Johnson	Surface Uranium Mine and Mill	on hold[d]		28
Cleveland-Cliffs In Situ Mines (also called Thunderbird Joint Venture)	PINTEC (Cleveland Cliffs Iron Co., Pioneer Nuclear, Texas Eastern Nuclear, Getty Oil, and Thunderbird Petroleum)	T. 44 N., R. 75 W. (Pumpkin Buttes)	Campbell	In Situ Solution Uranium Mines (2)	on hold[d]		29
Greasewood Creek Mine	Cleveland-Cliffs and Getty Oil	T. 44 N., R. 75 W. (Pumpkin Buttes)	Campbell	Surface Uranium Mine	on hold[d]		30
Moore Ranch Mine and Sand and Rock Mill	Continental Oil Co. and Kerr-McGee	T. 42 N., R. 75 W. (Pumpkin Buttes)	Campbell	Surface Uranium Mine and Mill	on hold[d]		31
Morton Ranch Project	TVA and United Nuclear Corp.	T. 35 N., R. 72 W. (20 miles northwest of Douglas)	Converse	Surface and Underground Uranium Mines and Mill	on hold[d]		32
Nine Mile Lake	Rocky Mountain Energy	T. 35 N., R. 79 W. (9 miles north of Casper)	Natrona	In Situ Uranium Mine	on hold[d]		33
North Butte Mine and Mill	Cleveland-Cliffs Iron Company and Getty Oil	T. 44 N., R. 75 W. (Pumpkin Buttes)	Campbell	Surface Uranium Mine and Mill	on hold[d]		34
Open Pit Mine	Kerr-McGee Nuclear Corp.	T. 37 N., R. 73 W. (Northwest of Douglas)	Converse	Surface Uranium Mine	1980[c]	1984[c]	35
Reno Ranch	Rocky Mountain Energy	T. 43 N., R. 73 W. (Southwest of Wright)	Campbell	In Situ Uranium Mine	1985	1986	36
Section 34 Mine	Kerr-McGee Nuclear Corp.	T. 36 N., R. 74 W. (Northwest of Douglas)	Converse	Underground Uranium Mine	1985	1988	37
SPRB Mill	Kerr-McGee Nuclear Corp.	T. 36 N., R. 74 W. (Northwest of Douglas)	Converse	Uranium Mill	1986	1988	38
Teton Exploration In Situ Mine	UNC-Teton-NEDCO	(30 miles north of Douglas)	Converse	In Situ Uranium Mine (pilot)	1980[e]	1982	39
Wyodak #2 Power Plant	Pacific Power & Light	T. 50 N., R. 71 W. (7 miles east of Gillette)	Campbell	Power Plant	1981	1987	40
Hampshire Energy Coal Liquefaction Project	Hampshire Energy	T. 48 N., R. 72 W. (14 miles south of Gillette)	Campbell	Coal Liquefaction Plant	1984	1986	41
ETSI Coal Slurry	Energy Transportation Systems, Inc.	(Eastern Wyoming)	Campbell, Weston, Converse, Niobrara, and Goshen	Coal Slurry Pipeline and Associated Facilities	1982	1985	42
Rocky Hill Site	ARCO	T. 44 N., R. 71 W. (Northeast of Reno Jct.)	Campbell	Experimental In Situ Coal Gasification	1981	unknown	43

Sources: Wyoming State Office, U.S. Bureau of Land Management; Wyoming Department of Economic Planning and Development, Mineral Development Monitoring System, revised March 1981.

[a]"Future" projects are defined as those that, if constructed, are projected to have production underway in 1981 or later.
[b]Project is currently on hold (P. Doreil, Great Plains Resources & Development Co., Laramie, personal communication, May 30, 1981).
[c]Existing, but on standby status.
[d]No present production and no current production plans.
[e]Non-commercial production.
[f]When project would encompass more than one township and range, given location is that of central facility or office.
[g]See Figure 6.2-2.

Table [illegible] continued

Project Name	Company	Location	Status	Target	Electricity Generation (MW)	Capacity (MW)	Reference[a]
Gila Bend Area	Sun-Edison Solar Corp.	[illegible] Southern of [illegible]	[illegible]	Commercial Grants [illegible]	[illegible]	[illegible]	[illegible]
Cherilla Sun Farm	Sunrise Corporation [illegible] Corporation (Los [illegible] Angeles)	[illegible] Cherilla [illegible]	[illegible]	Contract [illegible] [illegible]	[illegible]	[illegible]	[illegible]
Clearwater-Hillsdale in Blue Ridge Island Technology Solar Technical	WINTEC (Wisconsin Utility Light Corp., Pleasant Island, Texas Electric Utility, Dallas, and Tennessee Valley Authority)	[illegible] Wisconsin Island, Texas Dallas, Tennessee Valley	[illegible]	[illegible] Blue Ridge [illegible] Pleasant Island Corp.	[illegible]	[illegible]	[illegible]
Carrowood Grove Farm	Carrolsbrook Utility and Power Co.	[illegible] Carrolsbrook Utility Corp.	[illegible]	[illegible] Carrolsbrook Power Co.	[illegible]	[illegible]	[illegible]
Bonita Springs Plan and Fund and Farm Solar	Carrolsbrook Oil Co. and Sun-Edison	[illegible] Carrolsbrook Oil Co.	Commercial	Carrolsbrook Solar Power Co.	[illegible]	[illegible]	[illegible]
Solaris Farm Project	[illegible] and Solaris Corp.	[illegible] Southern California	Commercial	Solaris and Fresno Solar Power Corporation of [illegible]	[illegible]	[illegible]	[illegible]
Blue Hills Farm	Bluff Generate Corp.	[illegible] Bluff Generate [illegible] Corp.	Commercial	[illegible] Blue Hills Farm	[illegible]	[illegible]	[illegible]
Bear Creek Farm and Mill	Carrolsbrook Utility Corp. Company and Carry Oil	[illegible] Bear Creek Company	Commercial	[illegible] Bear Creek Farm and Mill	[illegible]	[illegible]	[illegible]
Dyer Fly Farm	Sun-Edison Solar Corp.	[illegible] Dyer Fly Farm [illegible] Southern California	Operation	Sun-Edison Solar Corp.	[illegible]	[illegible]	[illegible]
Bear Lewis	Bright Generate Corp.	[illegible] Bear Lewis	Commercial	[illegible] Bear Lewis	[illegible]	[illegible]	[illegible]
Sunrise 24 Mile	Sun-Edison Solar Corp.	[illegible] Sunrise 24 Mile [illegible]	Commercial	Sun-Edison Solar Corp. Mile	[illegible]	[illegible]	[illegible]
DFA Cell	Sun-Edison Solar Corp.	[illegible] DFA Cell [illegible]	Commercial	Sun-Edison [illegible]	[illegible]	[illegible]	[illegible]
Tetra Technologies in Lake Mine	Tetra-Edison Corp.	[illegible] Lake Mine [illegible]	Research	[illegible] Tetra Technologies	[illegible]	[illegible]	[illegible]
Wheeler Ft Farm Farm	Portlite Power & Light	[illegible] Wheeler Farm [illegible]	Commercial	Wheeler Farm	[illegible]	[illegible]	[illegible]
Bonneville Power and Electricity Project	Bonneville Power	[illegible] Bonneville [illegible]	Commercial	Bonneville Power Administration	[illegible]	[illegible]	[illegible]
[illegible] Coal Plant	Bonneville Transmission Operation System, Inc.	—Unknown Quantity	Feasibility Studies	[illegible] Coal Plant [illegible] Bonneville Power Administration	[illegible]	[illegible]	[illegible]
Bonneville Hill Solar	[illegible]	[illegible] Bonneville Hill [illegible]	Commercial	[illegible] Bonneville Power Administration	[illegible]	[illegible]	[illegible]

Sources: Sunshine State Solution, U.S. Bureau of Land Management, Solar Energy Generation of California Electric and Development, Mineral Technological Industrial Energy, Inventory Report, etc.

[a] "Status" projects are defined as state and. If commercial, the [illegible] is [illegible] in [illegible] in [illegible]. Projects in research or had [illegible] Commercial, Energy Water [illegible] Commercial [illegible] Energy Research Commercial. See [illegible], Feasibility, and on energy status.

[b] [illegible] and on [illegible] Commercial [illegible].

[c] [illegible] Commercial [illegible].

[d] [illegible] Solar [illegible] and [illegible] Facility [illegible] Solar [illegible] Facility [illegible] Solar [illegible] Facility [illegible] Solar

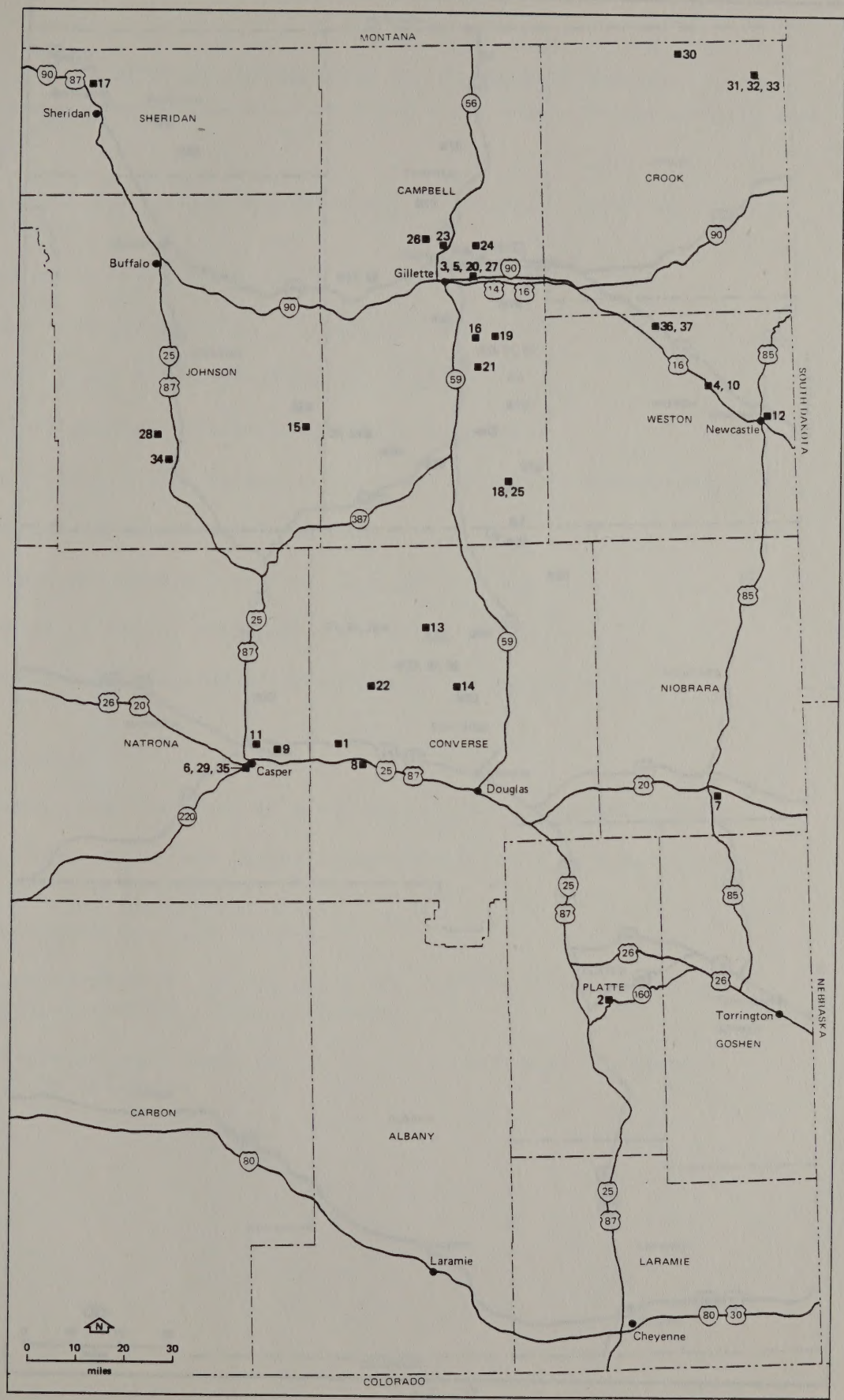
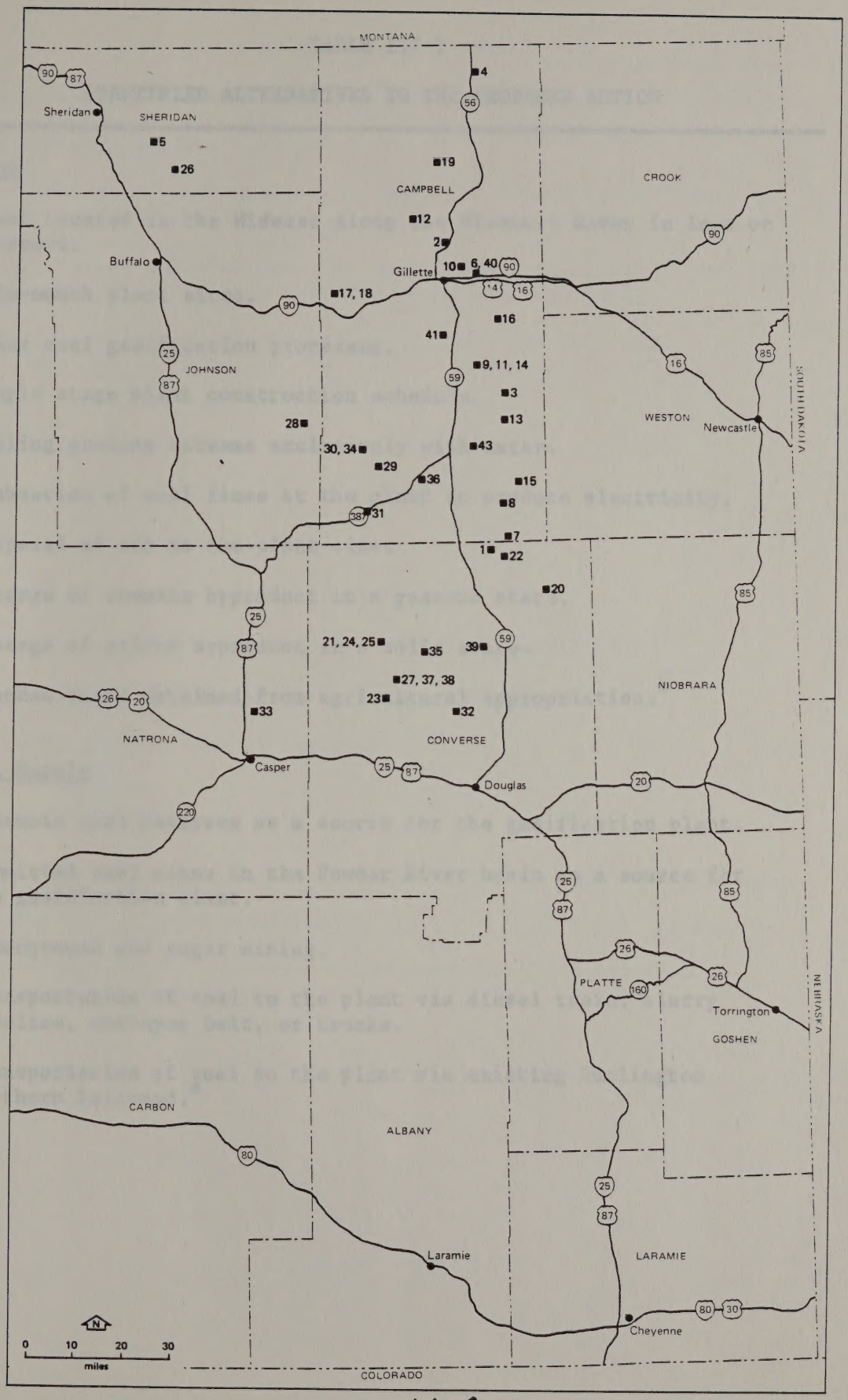


Figure ~~6.2-1.~~ 1.6-1

EXISTING PROJECTS IN THE WYCOALGAS PROJECT VICINITY (refer to Table ~~6.2-1~~ 1.6-1)



1.6-2

Figure ~~6.2.2.~~ 1.6-2

FUTURE PROJECTS IN THE WYCOALGAS PROJECT VICINITY (refer to Table ~~6.2.2~~)

TABLE 1.7-1

IDENTIFIED ALTERNATIVES TO THE PROPOSED ACTION

Plant

Plant located in the Midwest along the Missouri River in Iowa or Missouri.

Mine-mouth plant sites.

Other coal gasification processes.

Single stage plant construction schedule.

Cooling process streams exclusively with water.

Combustion of coal fines at the plant to produce electricity.

Disposal of ash at the plant site.

Storage of ammonia byproduct in a gaseous state.

Storage of sulfur byproduct in a solid state.

Process water obtained from agricultural appropriation.[b]

Coal Supply

Illinois coal reserves as a source for the gasification plant.

Permitted coal mines in the Powder River basin as a source for the gasification plant.

Underground and auger mining.

Transportation of coal to the plant via diesel train, slurry pipeline, conveyor belt, or trucks.

Transportation of coal to the plant via existing Burlington Northern Railroad.[a]

TABLE 1.7-1

IDENTIFIED ALTERNATIVES TO THE PROPOSED ACTION

Plant

Plant located in the Midwest along the Missouri River in Iowa or Missouri.

Mine-mouth plant site.

Other coal gasification processes.

Single stage plant construction schedule.

Cooling process stream exclusively with water.

Combustion of coal fines at the plant to produce electricity.

Disposal of ash at the plant site.

Storage of ammonia, byproduct in a gaseous state.

Storage of sulfur byproduct in a solid state.

Process water obtained from agricultural diversions.

Coal Supply

Illinois coal reserves as a source for the gasification plant.

Permitted coal mines in the Powder River basin as a source for the gasification plant.

Underground and auger mining.

Transportation of coal to the plant via tunnel system, slurry pipeline, conveyor belt, or trucks.

Transportation of coal to the plant via existing Burlington Northern Railroad.

TABLE 1.7-1 Concluded

Water Supply System

Substitution of groundwater for the North Platte River flood appropriation.[a]

Process water obtained from oil and gas production water, municipal waste water, or from the Oahe Reservoir.

Transportation of water from LaPrele Reservoir to Combs Reservoir by pipeline.

Product Pipeline

Alternatives routes:

- North to Ashland, Montana
- North to Dickinson, North Dakota
- Southeast to Louisburg, Kansas (three alternatives)
- South-southeast to Liberal, Kansas (two alternatives)
- South to west side of Cheyenne

Pipeline Diameter

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[a]Selected for detailed analysis.

[b]This alternative is currently under consideration; detailed analysis is not completed.

statement.

Three criteria were used to select reasonable alternatives to the proposed action for detailed impact analysis. These criteria are:

1. The alternative must provide a reasonable alternative to the proposed action. Alternatives which did not meet the purpose of the proposed action or were not reasonably available in the region under consideration were screened from detailed analysis. Reasonable alternatives also had to be technically possible; a process or technique was considered possible if it had been proven feasible in full operation or had been proven commercially successful and was in an advanced stage of development.

2. The alternative allows procurement of required permits for project implementation. Alternatives which would clearly cause the denial of an environmental permit to construct and/or operate for one or more of the project components were screened from detailed analysis.

3. The alternative represents an action which is clearly better than the proposed action in terms of fewer adverse environmental impacts.

Judgments as to whether the criteria were satisfied in each case were based on professional experience. Table 1.7-2 identifies the criteria by which particular alternatives were eliminated from detailed analysis. Further discussion of the alternatives that were screened out is provided below.

Alternatives Eliminated from Detailed Analysis

statement.

Three criteria were used to select reasonable alternatives to the proposed action for detailed impact analysis. These criteria are:

1. The alternative must provide a reasonable alternative to the proposed action. Alternatives which did not meet the purpose of the proposed action or were not reasonably available in the region under consideration were eliminated from detailed analysis. Reasonable alternatives also had to be technically possible; a process or technology was considered possible if it had been proven feasible in full operation or had been proven commercially successful and was in an advanced stage of development.

2. The alternative allows accomplishment of requested systems for project implementation. Alternatives which would significantly cause the denial of an environmental permit to construct and/or operate for one or more of the project components were screened from detailed analysis.

3. The alternative accomplishes an action which is significantly other than the proposed action in terms of direct effects, minimize material impacts.

Judgments as to whether the criteria were satisfied in each case were based on professional experience. Table 1-1 identifies the criteria by which particular alternatives were eliminated from detailed analysis. Further discussion of the alternatives that were screened out is provided below.

Alternatives Eliminated from Detailed Analysis

TABLE 1.7-2

SUMMARY OF SCREENING DECISIONS FOR ALTERNATIVES

Alternatives	Criteria for Screening from Detailed Analysis[a] 1	2	3
Midwest Plant	X		
Mine-Mouth Plant Sites		X	
Gasification Processes	X		
Single Stage Plant Construction			X
Plant Water Cooling	X		X
Ash Disposal at Plant		X	
Excess Electricity from Coal Fines			X
Gaseous Ammonia Storage			X
Solid Sulfur Storage			X
Illinois Coal Source	X		
Permitted Powder River Basin Mines			X
Underground Mining	X		X
Auger Mining	X		
Coal Transport by Diesel Train			X
Coal Transport by Slurry Pipeline	X		
Coal Transport by Conveyor Belt	X		X
Coal Transport by Truck	X		X
Process Water from Oil and Gas Production	X		
Process Water from Municipal Waste water	X		
Process Water from Oahe Reservoir	X		X
Product Transport from LaPrele Reservoir	X		X
Product Pipeline Routes			X
Pipeline Diameter	X		X

[a]Key to Criteria:

1 = The alternative does not provide a reasonable alternative to the proposed action.

2 = The alternative prevents procurement of a required permit for project implementation.

3 = The alternative does not provide an action which is clearly better than the proposed action in terms of environmental impacts.

TABLE 1.3-3

SUMMARY OF SCREENING DECISIONS FOR ALTERNATIVES

Alternatives	Criteria for Acceptance from Screening Analysis 1	2	3
Midwest Plant	X		
Mine-Mouth Plant Sites		X	
Coal/Leach Processes	X		
Single Stage Plant Construction			X
Plant Water Cooling	X		X
Ash Disposal at Plant		X	
Excess Electricity from Coal Plant			X
Caverns Economic Storage			X
Solid Sulfur Storage			X
Illinois Coal Source	X		
Permitted Powder River Basin Mines			X
Underground Mining	X		X
Auger Mining	X		
Coal Transport by Diesel Trains			X
Coal Transport by Slurry Pipeline	X		
Coal Transport by Conveyor Belt	X		X
Coal Transport by Truck	X		X
Process Water from Oil and Gas Production	X		
Process Water from Municipal Waste Water	X		
Process Water from Coke Manufacture	X		X
Product Transport from Lurgi/Rge Complex	X		X
Product Pipeline Routes			X
Pipeline Diameter	X		X

Key to Criteria:

1 = The alternative does not provide a reasonable alternative to the proposed action.

2 = The alternative presents insurmountable or a requisite permit for project implementation.

3 = The alternative does not provide an action which is clearly better than the proposed action in terms of environmental impacts.

Midwest Coal Source. Panhandle Eastern Pipe Line Company's present pipeline system originates in southwest Kansas and the panhandle regions of Texas and Oklahoma, and extends across the Midwest to Michigan. Due to their proximity to this pipeline system, Illinois coal reserves were considered as a source for the proposed gasification plant. However, eastern coals in general, including those in Illinois, are caking coals which are either not suitable, or offer a greater technical risk, for use in the Lurgi gasification process. Caking coals would clog the grates at the bottom of the gasifiers where ash is removed from the vessels. In order to use this type of coal in the process it would be necessary to reduce throughput to uneconomical levels.

Other Powder River Basin Mines . Coal from the Powder River Basin was chosen by WyCoalGas as a source for the plant because it is within a reasonable distance of the existing pipeline system and it has suitable characteristics for gasification in the Lurgi process. In addition to the proposed action of using coal from the Rochelle Mine, permitted mines in the Powder River Basin were also considered as a source for the plant. A review of the mine projects in the region indicates that the existing Rawhide and Black Thunder mines and the proposed Caballo Mine have sufficient undedicated reserves to meet the plant requirements.

Rochelle Coal Company plans to open the Rochelle Mine and market the coal whether or not the proposed plant is approved; therefore, the use of coal from alternative mines would not result in abandonment of development plans. For this reason, the alternatives must be evaluated on their individual merit. Since the physical and biological environments are relatively uniform over the portion of the Powder River

Basin where the alternative mines are located (U.S. Department of Interior 1979 and 1981), the major environmental difference among the mines are the emissions resulting from the transportation of coal to the proposed plant site. It can be reasonably assumed that the mode of transportation would be identical for all of the mines (see the discussion of coal transportation alternatives below); therefore, emissions would be a direct function of haul distance to the proposed plant. All of the permitted mines with sufficient reserves to meet the needs of the plant are located further from the plant site than the proposed Rochelle Mine; therefore, these alternatives were eliminated from further consideration.

The proposed Antelope Mine is the only permitted mine in the Basin that is closer to the plant site than is the Rochelle Mine. Even if the Antelope Mine were expanded to meet the plant requirement, these two mines are close enough to each other that the reduction in transportation-related emissions would not be large enough for the Antelope Mine to be a clearly better alternative in terms of fewer adverse environmental impacts.

Midwest Plant Site. Selection of a plant site by WyCoalGas included a review of sites in the Midwest along the Missouri River in Iowa and Missouri as well as sites near the coal source in Wyoming. The Midwest was considered because of the availability of water and labor.

It would be necessary to transport the coal and ash between a Wyoming mine and a plant in the Midwest by rail (refer to the discussion on coal transportation and ash disposal alternatives below). The environmental impacts associated with rail transport of coal and ash over a distance of at least 500 miles would be significantly greater than rail transport of these materials over roughly 40 miles and the

subsequent shipment of gas by pipeline from the plant to an intertie with the existing pipeline system. The product pipeline in the proposed project would normally cause only temporary construction-related impacts since the pipeline would be buried and the right-of-way revegetated, normal surveillance and maintenance would not require significant surface disturbance, and no new compressor stations would be installed. Long-distance transport of coal and ash by rail would probably require a greater long-term commitment of land to the project since it is expected that more than 40 miles of additional rail line would have to be constructed. In addition, increased air emissions and an increased loss of wildlife are likely.

Wyoming Plant Sites . An area within approximately a 60-mile radius of the proposed Rochelle Mine was examined for possible plant sites. The study area is relatively uniform from the standpoint of geological, ecological, hydrological/water quality, and meteorological/ air quality considerations (U.S. Department of Interior 1979 and 1981; U.S. Nuclear Regulatory Commission 1977). Therefore, these environmental parameters did not provide adequate screening criteria for plant siting.

In 1973 and 1974 when the plant site was selected, Gillette, located at the northern end of the study area, was experiencing severe socioeconomic problems due to rapid population growth associated with energy development. Corresponding conditions were not as severe in the communities of Casper, Glenrock, and Douglas, at the southern end of the study area. For this reason, a plant site location which directed project-related population growth towards these southern communities was preferred. In addition, much of the land north of the Rochelle Mine and west of Highway 59 was eliminated from further consideration because it was either underlain by economically recoverable reserves of coal and other minerals, or owned by the state or federal

government.

Three sites were selected within the study area for environmental, economic, and engineering design studies: a northern mine-mouth site, a southeast mine-mouth site, and a site near Douglas. The north and southeast plant sites were eliminated from further consideration because it would not be possible to obtain an air quality permit from the Wyoming Department of Environmental Quality to construct a mine-mouth facility. For this reason, mine-mouth plants at other permitted mines in the region were also eliminated from further consideration.

Gasification Process. There are only three large-scale, commercially proven coal gasification processes: Winkler, Lurgi, and Koppers-Totzek. The Wellman-Galusha gasification process is commercially proven (Schwieger 1979); but its design does not allow the construction of gasifiers large enough to economically produce large volumes of pipeline grade gas. It is estimated that roughly 140 Wellman-Galusha gasifiers would be required to produce the volume of high Btu gas proposed for this project.

The Lurgi process was chosen over the other two large-scale, first generation gasifiers on the basis of energy efficiency. The efficiencies of the three units are as follows (Schwieger 1979):

Process	Efficiency (%)
Lurgi	76
Winkler	69
Koppers-Totzek	68

In addition to having a greater efficiency, the Lurgi gasifier produces gasifiable liquid hydrocarbons which are not produced in the

government.

Three sites were selected within the study area for environmental, economic, and engineering design studies: a northern mine-mouth site, a southeast mine-mouth site, and a site near Denver. The north and southeast plant sites were eliminated from further consideration because it would not be possible to obtain an air quality permit from the Wyoming Department of Environmental Quality to construct a mine-mouth facility. For this reason, mine-mouth plants or other potential mines in the region were also eliminated from further consideration.

Gasification Process. There are only three large-scale, commercially proven coal gasification processes: Mobil, Lurgi, and Koppers-Totzek. The Williams-Saline gasification process is commercially proven (Schwager 1978); but its design does not allow the construction of gasifiers large enough to economically produce large volumes of pipeline quality gas. It is estimated that roughly 140 Williams-Saline gasifiers would be required to produce the volume of high Btu gas proposed for this project.

The Lurgi process was chosen over the other two large-scale, first generation gasifiers on the basis of energy efficiency. The efficiencies of the three units are as follows (Schwager 1978):

Process	Efficiency (%)
Lurgi	74
Winkler	67
Koppers-Totzek	58

In addition to having a greater efficiency, the Lurgi gasifier produces gasifiable liquid hydrocarbons which are not produced in the

other two units.

Approximately 40 percent of the gas produced from coal in the Lurgi gasifier is methane, while no methane is produced during initial gasification in the Winkler and Koppers-Totzek processes. For this reason, much more oxygen is required to produce methane in the Winkler and Koppers-Totzek processes than in the Lurgi process. This increased oxygen demand substantially increases the amount of electricity required for plant operation, further reducing the overall efficiency of the Winkler and Koppers-Totzek processes relative to the Lurgi process.

Both Winkler and Koppers-Totzek gasifiers operate at atmospheric pressures, requiring considerable compression of the product gas in order to ship it by pipeline. The Lurgi process is pressurized, which reduces the need for further compression of the gas, resulting in an overall decrease in the energy requirement of the plant relative to the other two processes.

Plant Construction Schedule. The alternative of constructing the plant in a single stage was considered. The approximate labor force required for such a construction schedule, relative to the proposed action, is presented in Figure 1.7-1.

As discussed in Chapter Three, significant socioeconomic impacts would result from two-staged construction of the proposed plant. A single-stage construction schedule would significantly increase these impacts; therefore, this alternative was eliminated from further consideration.

Plant Cooling System. The quantity of water required for a conventionally water cooled gasification plant would be approximately

other two units.

Approximately 40 percent of the gas produced from coal in the Lurgi gasifier is methane, while no methane is produced during Lurgi gasification in the Winkler and Koppers-Totzek processes. For this reason, much more oxygen is required to produce methane in the Winkler and Koppers-Totzek processes than in the Lurgi process. This for creased oxygen demand substantially increases the amount of electricity required for plant operation, further reducing the overall efficiency of the Winkler and Koppers-Totzek processes relative to the Lurgi process.

Both Winkler and Koppers-Totzek gasifiers operate at atmospheric pressures, requiring considerable compression of the product gas in order to ship it by pipeline. The Lurgi process is pressurized, which reduces the need for further compression of the gas, resulting in an overall decrease in the energy requirements of the plant relative to the other two processes.

Plant Construction Schedule. The alternative of constructing the plant in a single stage was considered. The overall manpower labor force required for such a construction schedule, relative to the proposed action, is presented in Figure I.7-1.

As discussed in Chapter Three, significant socioeconomic impacts would result from two-stagged construction of the proposed plant. A single-stage construction schedule would significantly increase these impacts; therefore, this alternative was eliminated from further consideration.

Plant Cooling System. The quantity of water required for a conventionally water cooled gasification plant would be approximately

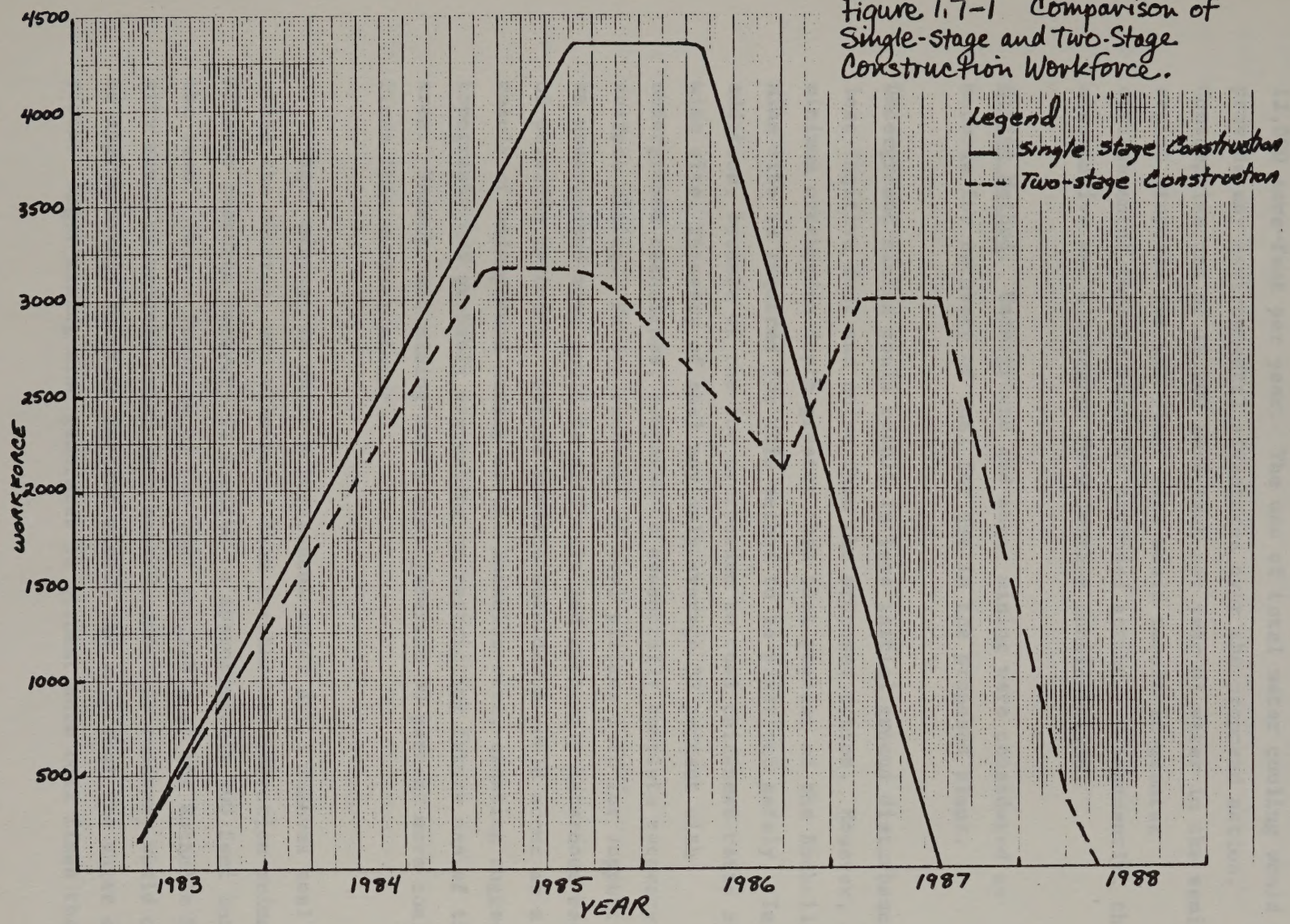


Figure 1.7-1 Comparison of Single-Stage and Two-Stage Construction Workforce.

12,000 acre-feet per year. The use of total water cooling would not provide any environmental advantages over the proposed action. Consumptive use of 12,000 acre-feet per year of water in the semiarid region proposed for the plant site would result in greater environmental impacts than the proposed action. Consequently, this alternative was eliminated from further consideration.

Mining Method. Underground and auger mining were considered as methods for recovery of coal for use in the proposed plant.

Underground mining could result in less initial ground disturbance and less fugitive dust and noise than the proposed action. However, a minimum overburden depth greater than that present at the Rochelle Mine site is required for this method to be practiced safely. In addition, because of the low overburden to coal thickness ratio at the mine site, recovery of coal may only average 50 percent with underground techniques, compared to essentially complete recovery with surface mining. Future recovery of coal pillars left for support in an underground mine would be difficult and extremely hazardous because of possible cave-ins. Severe surface subsidence could occur as a result of underground mining at the Rochelle site, creating rugged topography and probably preventing or restricting future use of the area. Underground mining would also generate 50 percent more coal fines than surface mining.

Auger mining, in which a horizontal auger drill removes coal along the outcrop, was eliminated from further consideration primarily because resource recovery is limited to approximately 200 feet into the seam. Only a fraction of the coal available at the Rochelle Mine site would be removed using this method, and coal recovery would only be approximately 50 to 60 percent within the zone that the auger could reach. Auger mining also generates 50 percent more coal fines than

surface mining. With this limited efficiency, it is unlikely that sufficient coal could be recovered from the mine to supply the needs of the plant.

Coal Transportation. In addition to the proposed use of electric trains, the following alternatives were considered for the transportation of the coal from the mine to the plant.

- Diesel train
- Slurry pipeline
- Conveyor belt
- Trucks

To equal the design capabilities of the proposed electric train system, diesel locomotives with a total output of 6,000 horsepower would be required. Emissions from the diesel engines would be significantly higher for most pollutants than those associated with the production of the electricity necessary for the proposed action. In addition, diesel emissions would occur at ground level, while emissions from the electrical power plant would occur at a height of roughly 300 feet; consequently, ground level concentrations of all pollutants would be greater for diesel than for the electric train. Noise produced by diesel trains would also be significantly greater than from electric trains. For these reasons, the use of diesel trains to transport coal to the plant was eliminated from further consideration.

In order to transport coal via a slurry pipeline, the coal must be reduced in size so that it passes through at least a 14-mesh sieve (1.41 millimeters). The Lurgi gasifier cannot economically process coal finer than 1/8 inch in size. Consequently, the use of a coal slurry pipeline does not constitute a reasonable alternative to the

proposed action.

Conveyor belts longer than roughly five miles are not technically feasible. Therefore, it would be necessary to transfer the coal at least seven times between the proposed mine and plant if this system were used. Approximately two to three percent additional coal fines would be produced at each transfer point. Since these fines cannot be used in the Lurgi gasifiers, an additional 2 million tons/year of coal would have to be mined to make up for the loss and a total of 3.5 million tons/year of coal fines would have to be sold.

Safety specifications require that the conveyors be protected by fire prevention systems. Water supplies, sprays, and detection equipment for such a system would be extensive and almost impossible to maintain.

For safety purposes, it would be necessary to fence the conveyor system. This fence, as well as the conveyor belts themselves, would provide an effective barrier to the movement of big game (particularly pronghorn antelope) and livestock. Since the proposed action would not require construction of a fence, it would not create as great a barrier.

This alternative was eliminated from further consideration because it is less reliable than the proposed action. In addition, transportation of coal by conveyor belt would result in significantly greater biological impacts than transportation by train.

Transportation of coal to the plant in trucks does not provide a reasonable alternative to the proposed action. If 120-ton dump trucks were used for such an operation, a total of approximately 270 trips/day would be required. Since this size vehicle could not oper-

ate on public roads, a private haul road would have to be constructed, resulting in essentially the same environmental impacts as the proposed action. Particulate emissions from the trucks are expected to be substantially greater than those generated by the proposed action while emissions of other pollutants would be at least equal to the proposed action. The use of conventional size trucks to supply coal to the plant is not feasible since more than 6,000 trips/day would be necessary.

Water Supply. The following alternative water supplies for the proposed plant were considered.

- water from oil and gas production
- municipal waste water
- Oahe Reservoir water

Oil and gas wells in the vicinity of the proposed project do not produce sufficient waste water to meet process needs. Diversion of this water from other basins is prohibited by state law.

Conventional waste water treatment techniques do not reduce the concentration of organic compounds in municipal waste water to a low enough level for this water to be used in the steam generation circuit of the proposed plant. In addition, treated waste water from the communities in the vicinity of the plant must be discharged to a surface drainage; this requirement includes water from underground sources. This is the normal procedure for communities in Wyoming (L.E. Allen, Wyoming State Engineer's Office, personal communication, 1981). In most cases, this water is appropriated to other uses as a part of the surface water supply, and downstream users are dependent on it as a part of the total water supply. For these reasons, this alternative was eliminated from further consideration.

Transportation of water from the Oahe Reservoir in South Dakota to the proposed plant site would require the construction of a pipeline at least 300 miles long. Due to the relatively small quantity of water required for the project, this alternative is not economically feasible.

Water Supply System. The alternative of transporting water from LaPrele Reservoir to Combs Reservoir by pipeline was considered. However, this was not possible because the project water appropriation stipulates that WyCoalGas transport LaPrele Reservoir water down the natural channels of LaPrele Creek and the North Platte River.

In addition to this requirement, it is apparent that transportation of the water via a pipeline would create more environmental impacts than the proposed action. Construction of the pipeline would cause surface disturbance and stream sedimentation that would not result from the proposed action. As discussed in Chapter Three, the proposed water supply system operating schedule would increase flows in LaPrele Creek and enhance the aquatic habitat. This positive effect would not occur if the water were transported by pipeline.

Power Production From Excess Coal Fines. The alternative of installing another package boiler at the plant to produce electricity from the excess coal fines was considered.

Excess fines sold to a local power plant would supplement existing coal sources. Therefore, the only impacts associated with the proposed action and not with this alternative would be from rail transport of the fines from the gasification plant to another location.

Combustion of the fines to product electricity at the plant would increase boiler-related emissions from the plant and increase project water consumption by approximately 2,000 to 3,000 acre-feet per year. The electricity would have to be sold to a local power company, resulting in a possible increase in the total length of new transmission lines required for the project. The electricity could not be used in the plant since sufficient power would already be produced by the proposed action. The electrical power system of the plant, even with another boiler, would not be adequate to meet the peaking single-phase needs of the railroad.

The net impacts associated with this alternative were considered to be greater than those caused by the proposed action. Therefore, the alternative was eliminated from further consideration.

Product Pipeline Routes. In addition to the proposed action, eight alternative pipeline routes were considered that would connect the proposed plant to the existing Panhandle Eastern pipeline system (Figure 1.7-2). Except for route H, all of the alternatives are significantly longer than the proposed action (Table 1.7-3), and would have proportionally greater environmental impacts associated with surface disturbance during construction. All routes except B and H have more major stream crossings than the proposed action (Table 1.7-3). Route B crosses the Stewart Lake National Wildlife Refuge, White Lake National Wildlife Refuge, and Bowman-Haley Reservoir and National Wildlife Refuge (Woodward-Envicon 1973). No national wildlife refuges are crossed by the proposed product pipeline right-of-way. Primarily for these reasons, all of the alternative alignments except Route H were eliminated from further consideration.

In accordance with FLPMA, the BLM has instituted a policy to establish corridors around existing energy transmission and

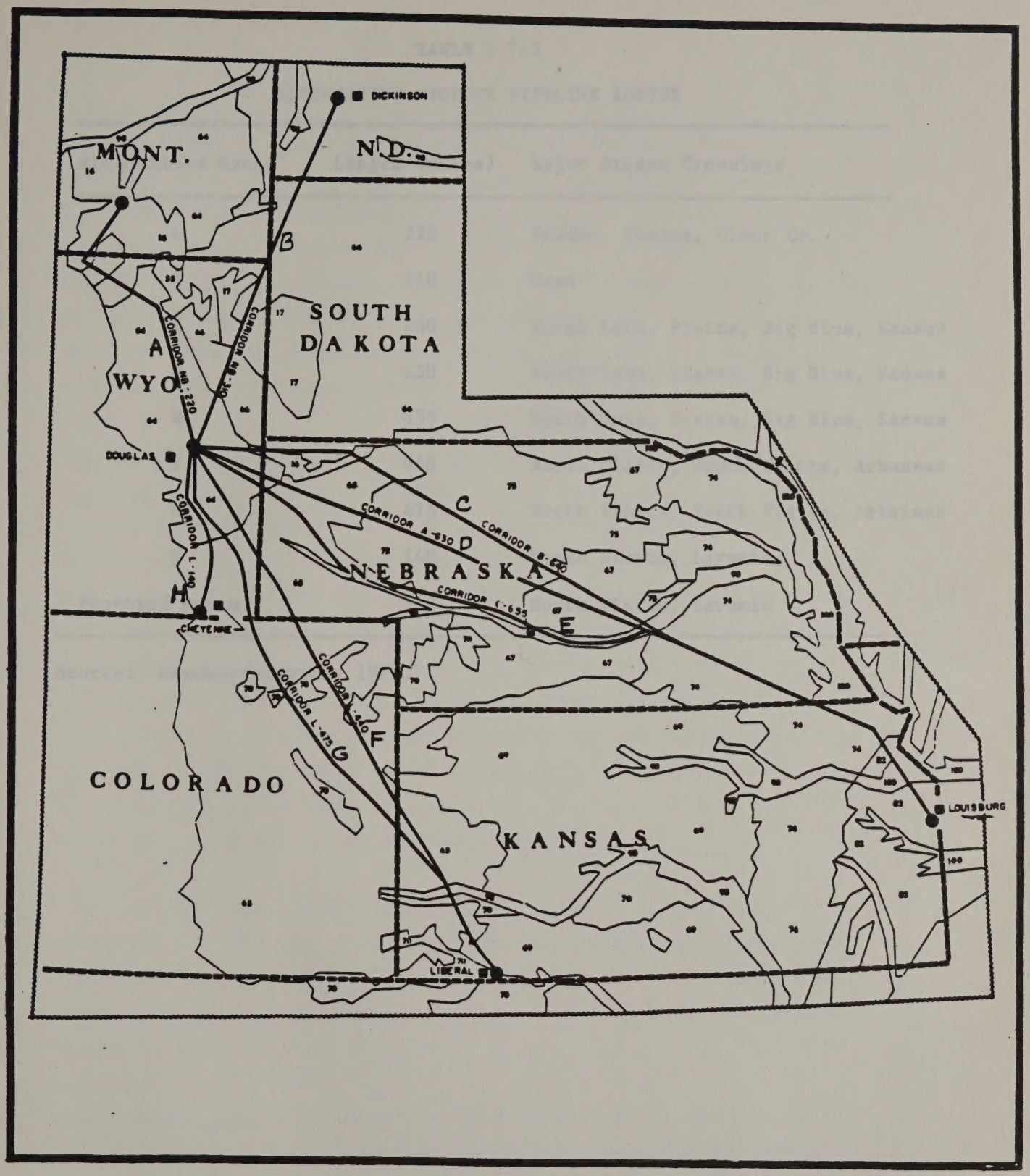


Figure 1.7-2 Alternative Product Pipeline Routes

TABLE 1.7-3

ALTERNATIVE PRODUCT PIPELINE ROUTES

Alternative Route[a]	Length (miles)	Major Stream Crossings
A	220	Powder, Tongue, Clear Cr.
B	310	None
C	640	South Loup, Platte, Big Blue, Kansas
D	630	South Loup, Platte, Big Blue, Kansas
E	655	South Loup, Platte, Big Blue, Kansas
F	440	North Platte, South Platte, Arkansas
G	475	North Platte, South Platte, Arkansas
H	140	North Platte, Laramie
Proposed Route	160	North Platte, Laramie

Source: Woodward-Envicon 1973.

TABLE I.7-3

ALTERNATIVE PROPOSED PIPELINE ROUTES

Alternative Route*	Length (miles)	Major Stream Crossings
A	320	Powder, Tongue, Clear Cr.
B	310	None
C	640	Bonds Loop, Prairie, Big Sioux, Kansas
D	630	Prairie Loop, Platte, Big Sioux, Kansas
E	633	Bonds Loop, Platte, Big Sioux, Kansas
F	640	North Platte, South Platte, Arkansas
G	675	North Platte, South Platte, Arkansas
H	640	North Platte, Arkansas
Proposed Route	560	Bonds Ranch, Laramie

Source: Woodward-Clyde (1973).

transportation facilities, and to consider new corridors only when location within a compatible distance of existing facilities is infeasible, and where environmental impacts can be mitigated. The U.S. Forest Service has established a similar policy under the National Forest Management Act (NFMA) of 1976. To comply with this policy, the proposed pipeline route would parallel an existing Conoco pipeline for approximately 50 percent of its length. Route H does not parallel an existing transmission corridor over any of its length; therefore, it was eliminnated from further consideration.

Pipeline Diameter. As discussed above, the proposed product pipeline would tie into an existing transmission system near the Colorado-Wyoming border. This existing system is operated at a pressure of approximately 750 psig; consequently, the product pipeline must operate at a higher pressure in order for the gas to enter the existing line. Based on the length of the product pipeline, it would be necessary to discharge gas from the plant at approximately 1,440 psig in order for it to flow into the existing system without the installation of an extra compressor station between the plant and the intertie. Pipe for gas transmission lines is manufactured in pressure classes. There is a class of pipe with a pressure limit of 1,440 psig; this class was chosen for the proposed action.

The existing system at the proposed intertie is 24 inches in diameter; consequently, this represents the upper limit of the product pipeline diameter. Pipe in the 1,440-psig class below 24 inches in diameter does not have sufficient capacity to transport the proposed volume of gas.

Ash Disposal Site. Burial at the plant site of ash produced from process streams was considered as an alternative to the proposed action. Because of increased particulate emissions from plant-site

transportation facilities, and to consider new corridors only when location within a comparable diameter of existing facilities is infeasible, and where environmental impacts can be minimized. The U.S. Forest Service has established a similar policy under the National Forest Management Act (NFMA) of 1976. In comply with this policy, the proposed pipeline route would parallel an existing Conoco pipeline for approximately 50 percent of its length. Where it does not parallel an existing transmission corridor over any of the lands, therefore, it was eliminated from further consideration.

Pipeline Diameter. As discussed above, the proposed product pipeline would tie into an existing transmission system near the Colorado-Wyoming border. This existing system is operated at a pressure of approximately 750 psig; consequently, the product pipeline must operate at a higher pressure in order for the gas to enter the existing line. Based on the length of the product pipeline, it would be necessary to discharge gas from the plant at approximately 1,500 psig in order for it to flow into the existing system without the installation of an extra compressor station between the plant and the interties. Pipe for gas transmission lines is manufactured in various classes. There is a class of pipe with a pressure limit of 1,500 psig; this class was chosen for the proposed action.

The existing system at the proposed interties is 20 inches in diameter; consequently, this represents the upper limit of the product pipeline diameter. Pipe in the 1,500-psig class below 24 inches in diameter does not have sufficient capacity to accommodate the proposed volume of gas.

Sub Proposal Site. Burial at the plant site of ash produced from process streams was considered as an alternative to the proposed action. Factors of increased particulate emissions from plant-site

burial, it would not be possible to obtain an air quality permit to construct if this alternative were implemented.

Burial of ash at other sites remote from the plant would result in higher particulate emissions than the proposed action. Some additional miles of railroad line would also have to be constructed to the disposal site.

Byproduct Storage. The proposed gasification process would generate ammonia and sulfur as byproducts. Ammonia can be stored as a gas or liquid while sulfur can be stored as a liquid or solid.

Ammonia in the quantities to be produced at the plant is essentially always stored in liquid form. Storage in the gaseous state would require the construction of tanks at least an order of magnitude larger in size than those for the proposed action, and would not provide significant environmental or safety advantages; therefore, this alternative was eliminated from further consideration.

Sulfur in the solid state would be stored in blocks. These blocks would be subject to water erosion which could potentially result in increased concentrations of sulfur compounds in local surface and/or ground waters. This potential impact was considered more significant than impacts associated with the proposed action; therefore, the alternative was eliminated from further consideration.

Shipment of Byproducts. Markets have not yet been identified for the byproducts from the gasification plant. Depending on the distance between the plant and eventual market, byproducts may be shipped by truck or rail. The difference in the impacts associated with these two modes of transportation under both normal and nonroutine operating conditions was not considered large enough for either alternative to

burial, it would not be possible to obtain an air quality permit to construct if this alternative were implemented.

Burial of ash at other site remote from the plant would result in higher particulate emissions than the proposed action. Some additional miles of railroad line would also have to be constructed to the disposal site.

Byproduct Storage. The proposed gasification process would generate ammonia and sulfur as byproducts. Ammonia can be stored as a gas or liquid while sulfur can be stored as a liquid or solid.

Ammonia is the quantities to be produced at the plant is economically always stored in liquid form. Storage in the gaseous state would require the construction of tanks at least an order of magnitude larger in size than those for the proposed action, and would cost previde significant environmental or safety advantages; therefore, this alternative was eliminated from further consideration.

Sulfur in the solid state would be stored in bins. These bins would be subject to water scrubs which could potentially result in increased concentrations of sulfur compounds in local surface and/or ground waters. This potential impact was considered more significant than impacts associated with the proposed action; therefore, the alternative was eliminated from further consideration.

Shipment of Byproducts. Markets have not yet been identified for the byproducts from the gasification plant. Depending on the distance between the plant and eventual market, byproducts may be shipped by truck or rail. The difference in the impacts associated with these two modes of transportation under both normal and nonnormal operating conditions was not considered large enough for either alternative to

be clearly better than the other from an environmental standpoint.

For purposes of the impact assessment, it has been assumed that both byproducts of the process would be shipped by rail, the ammonia to Pocatello, Idaho, and the sulfur to Denver, Colorado. This alternative appeared to be the most reasonable worst-case action.

Alternatives Considered for Detailed Analysis

Coal Transportation. The relative environmental impacts of transportating coal from the Rochelle Mine to the plant via an existing Burlington Northern (BN) rail line are addressed in Chapter Three of the Environrmental Impact Statement. This existing line runs roughly north-south between Gillette and Orin/Shawnee, Wyoming. It ties the BN rail line that parallels Highway 16 in northeastern Wyoming with the BN and Chicago & Northwestern lines that run east-west in the middle of the state. The line was constructed to transport coal from mines in the eastern Powder River Basin to national markets.

In the vicinity of the proposed project, the BN passes approximately eight miles west of the Rochelle Mine site, flanks the west side of the Red Hills, and parallels Highway 59 from approximately five miles north of Bill to the proposed plant site. For this alternative, a spur line would be required from the Rochelle Mine to the existing BN line. Since the BN railroad crosses the property WyCoalGas has leased for the plant, all that would be required for unloading the coal would be a short spur and a loop at the plant site.

The rail spur alignment at the mine would be identical to the proposed action from the mine to approximately the crossing at Ante-

lope Creek. From this point, the spur would extend west through Antelope Creek valley to the existing BN line. The spur would be a single track constructed in a manner similar to the proposed action.

For purposes of the impact analysis, it was assumed that the operating schedule of this transportation altrnative would be the same as the proposed action. After project termination, the spur tracks would be salvaged, the ballast would be returned to the mine for burial, and the right-of-way would be reclaimed in a manner similar to the proposed action.

Water Supply. While modeling of the North Platte River system (see the Hydrology Technical Report and Chapter Three indicates that there is sufficient surface water available for project needs, erratic climatic conditions in Wyoming suggest that the flood appropriation from the North Platte River may not be obtainable for some years during the life of the plant. Since the number of years when this water is unavailable cannot be definitely determined, a worst-case alternative assuming that none of the flood appropriation could be used for the life of the project was included in this environmental assessment.

This alternative assumes that 4,000 acre-feet/year of water would be available from LaPrele Reservoir and that the remaining 2,000 acre-feet/year of water required for the plant would be obtained from either the North or South Well Field. Since operating criteria for these well fields have not been developed, the impacts of pumping all 2,000 acre-feet/year from each well field were analyzed.

The alternative of purchasing existing agricultural water rights and converting them to industrial use for this project is being considered.

No Action. In the event that the proposed project was not implemented, Panhandle Eastern would have to continue seeking domestic and foreign sources of natural gas. If sufficient supplies could not be found, new customers would have to be turned down. As a last resort, the gas supplies to existing customers would have to be reduced.

Chapter 2
AFFECTED ENVIRONMENT

The affected environment is the area affected by the proposed action or any alternative considered in detail. The affected environment for the proposed action and alternatives was analyzed for all of the following resources:

- Climate, air quality, and noise
- Geology, topography, geologic hazards, and paleontology
- Soils (including alluvial valley floors)
- Water resources (including 100-year floodplains)
- Vegetation
- Wildlife
- Aquatic biology
- Threatened and endangered species
- Recreation and wilderness resources
- Visual resources
- Land use (including agriculture and minerals)
- Cultural resources
- Socioeconomics

Existing land use plans, controls, and constraints were also reviewed for potential conflicts with the proposed action and alternatives. This chapter provides information about only the resources that would be affected as determined by the impact analysis in Chapter 3. The analyses indicated that several resources would not be affected, therefore, descriptions of the following resources were not included:

- Paleontological resources and unique geologic features
- Geologic hazards are discussed only where pertinent to health and safety
- Alluvial valley floors
- Federal threatened or endangered plant species
- Wilderness areas, wilderness study areas, RARE II areas, or state wilderness/natural areas
- Prime farmlands

Baseline data were collected for each resource topic for all project components to a distance where impacts could no longer be identified with the project. This area is defined as the affected area. Criteria defining the limitations of impacts to their significant or insignificant levels are given for each resource topic under Assumptions and Assessment Guidelines. For some resources, such as vegetation and soils, the affected area is confined to the immediate vicinity of construction sites. For other resources, such as socioeconomics or recreation resources, the affected area may extend 60 miles or more beyond construction sites.

Various project alternatives overlap completely or in part with the proposed action. In accordance with the Council on Environmental Quality regulations, the affected environment common to the proposed action and the alternatives will only be described for the proposed action.

2.1 CLIMATE, AIR QUALITY, AND NOISE

General

The proposed project region is located in the North Platte Plateau in the southern portion of the Powder River Basin, an area of prairies and rolling hills. As a result of the effective barrier to

- Paleontological resources and unique geologic features
- Geologic hazards are discussed only where pertinent to health and safety
- Alluvial valley floors
- Federal threatened or endangered plant species
- Wilderness areas, wilderness study areas, RARE II areas, or state wilderness/natural areas
- Prime farmlands

Baseline data were collected for each resource topic for all project components to a distance where impacts could no longer be identified with the project. This area is defined as the affected area. Criteria defining the limitations of impacts to their significance or insignificance levels are given for each resource topic under Assumptions and Assessment Guidelines. For some resources, such as vegetation and soils, the affected area is confined to the immediate vicinity of construction sites. For other resources, such as socioeconomics or recreation resources, the affected area may extend 50 miles or more beyond construction sites.

Various project alternatives evaluated tentatively or in part with the proposed action. In accordance with the Council on Environmental Quality regulations, the effects analysis, common to the proposed action and its alternatives, will only be described for the proposed action.

2.1 CLIMATE, AIR QUALITY, AND NOISE

Climate

The proposed project region is located in the North Platte Bias- tan in the southern portion of the Powder River Basin, an area of prairies and rolling hills. As a result of the effective barrier to

moisture from the Pacific Ocean offered by the Cascade, Sierra Nevada, and Rocky mountains when the winds are from the west and northwest, the climate of this region is considered semiarid continental. The bulk of the annual precipitation is from moisture-laden easterly winds, particularly during the spring months (National Oceanic and Atmospheric Administration 1975a). Generally, this region has considerable sunshine, low relative humidity, and light precipitation. Neither the summers nor winters are particularly severe. With the blockage of large-scale weather patterns by the mountains, the local topography and small-scale meteorologic conditions exert a strong influence on the climate of any specific location.

Meteorological data representative of the region are available from a number of National Weather Service and Federal Aviation Administration climatological recording stations. These include Casper (55 miles east of project site), Douglas (16 miles southwest of site), Moorcroft (110 miles north of site), and Sheridan (140 miles northwest of the site), Wyoming. Long-term data from these locations provide information from which the characteristics of the meteorological conditions for the project area can be obtained. In addition, site-specific meteorological and air quality data are available from 1973 to 1978.

A brief summary of data describing the affected environment is presented below. A detailed discussion of meteorological parameters representative of conditions in the project area is presented in the Meteorology, Air Quality, and Noise Technical Report (WCC 1981b).

Plant Site

Climate.

Temperature. Representative temperatures in the project region are presented in Table 2.1-1. These data show good agreement with temperature data collected at the project monitor station. The mean annual temperature for the region is about 45°F. The warmest month of the year is July, with an average temperature of about 71°F. The coldest month is January with an average temperature around 22°F.

Precipitation. The average annual precipitation in Casper from 1941 through 1970 was 11.22 inches, while Sheridan (north of Casper) had an annual average of 16.16 inches. Table 2.1-2 presents precipitation data for Douglas and Moorcroft. These tables indicate that the project region receives about 12 inches of precipitation annually. Wide seasonal and annual variations in precipitation result from variations in spring and summer thunderstorm activity. Heavy thunderstorms can produce 25 to 50 percent of the total annual precipitation in any given year. Annual snowfall in the Casper area averaged 74.2 inches between 1951 and 1975. The highest yearly total, 116.8 inches, was reported at Casper during the 1972-1973 season; the lowest, 33.6 inches, was reported during the 1941-1942 season.

Wind Speed and Direction. Figure 2.1-1 presents an annual wind rose for Casper. Figure 2.1-2 presents an annual wind frequency distribution for the proposed site. Tables 2.1-3 and 2.1-4 provide a summary of mean monthly wind speeds and prevailing wind directions for Casper and the proposed plant site. The mean annual wind speeds are 13.1 mph for Casper and 16.6 mph at the proposed site, with the strongest winds in the winter season. Southwesterly winds predominate throughout the year at Casper while west-southwesterly winds dominate at the proposed site.

Plant Site

Climate

Temperature. Representative temperatures in the project region are presented in Table 2.1-1. These data show good agreement with temperature data collected at the project monitor station. The mean annual temperature for the region is about 45°F. The warmest month of the year is July, with an average temperature of about 71°F. The coldest month is January with an average temperature around 12°F.

Precipitation. The average annual precipitation in Casper area (1941 through 1970) was 11.72 inches, while Sheridan (north of Casper) had an annual average of 15.16 inches. Table 2.1-2 presents precipitation data for Douglas and Moorcroft. These tables indicate that the project region receives about 12 inches of precipitation annually. While seasonal and annual variations in precipitation result from variations in spring and summer thunderstorm activity. Heavy thunderstorms can produce 25 to 50 percent of the total annual precipitation in any given year. Annual snowfall in the Casper area averaged 74.7 inches between 1931 and 1972. The highest yearly total, 115.8 inches, was reported at Casper during the 1972-1973 season; the lowest, 32.4 inches, was reported during the 1941-1942 season.

Wind Speed and Direction. Figure 2.1-1 presents an annual wind rose for Casper. Figure 2.1-2 presents an annual wind frequency distribution for the proposed site. Tables 2.1-3 and 2.1-4 provide a summary of mean monthly wind speeds and prevailing wind directions for Casper and the proposed plant site. The mean annual wind speeds are 13.1 mph for Casper and 16.6 mph at the proposed site, with the strongest winds in the winter season. Southwesterly winds predominate throughout the year at Casper while west-northwesterly winds dominate at the proposed site.

TABLE 2.1-1

NORMALS, MEANS, AND EXTREMES OF TEMPERATURES (°F)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Douglas	extreme maximum	64	70 (62)	79	83 (62)	93	102	105	100	96	87 (63)	75 (77)	70	105
	mean maximum	37	41	46	56	67	78	87	85	74	63	47	40	60
	mean normal	23	27	32	43	53	62	71	69	58	47	34	26	45
	mean minimum	10	15	19	29	40	48	54	47	41	30	19	13	31
	extreme minimum	-38 (72)	-29 (62)	-27	-12 (66)	13	27	34(72)	29(64)	18	-6 (71)	-24	-38 (64)	-38 (64)
Casper AP	extreme maximum	60 (71)	65 (72)	73	81	91 (61)	101	104	99	96 (/8)	85	71 (65)	61 (73)	104
	mean maximum	33	38	43	55	67	78	87	85	74	61	44	36	58
	mean normal	23	27	32	42	52	62	71	69	58	47	33	26	45
	mean minimum	13	17	20	29	39	48	55	53	43	33	22	16	32
	extreme minimum	-40	-19	-21 (65)	-4 (66)	16	28	30	33	15	-9	-20	-34 (76)	-40
Moorcroft	extreme maximum	58	67	74	84	96	102(61)	106	102	98	90	75	64 (73)	106
	mean maximum	31	36	42	54	65	76	86	85	72	60	43	34	57
	mean normal	19	24	31	42	53	63	71	69	58	48	32	23	44
	mean minimum	8	13	20	30	40	49	56	54	43	33	21	12	32
	extreme minimum	-37	-42	-24	-19	8	28 (70)	35(68)	35(64)	18	5	-26	-35 (64)	-42
Sheridan AP	extreme maximum	70	73 (51)	77 (78)	87 (46)	96	107	107	105 (49)	104	91 (63)	78	78	107
	mean maximum	33	39	44	56	66	76	86	84	73	62	46	37	58
	mean normal	20	25	32	44	53	62	70	68	57	46	18	10	42
	mean minimum	8	15	20	30	40	48	54	52	42	32	20	10	31
	extreme minimum	-35	-31 (49)	-23 (65)	-2 (7-)	13 (54)	27 (51)	35	34	15 (65)	1 (71)	-25 (59)	-30 (72)	-35 (64)

Source: Bureau of Land Management 1980.
Douglas FAA Airport; elevation 4,853 feet MSL.
Casper WB Airport; elevation 5,319 feet MSL.
Moorcroft; elevation 4,265 feet MSL.
Sheridan WB Airport; elevation 3,942 feet MSL.
Numbers in parentheses are the years of occurrence.

TABLE 2.1-2

MEAN AND MAXIMUM MONTHLY PRECIPITATION (inches) -
MOORCROFT AND DOUGLAS, WYOMING

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period of Record
Moorcroft														
Mean Monthly	0.37	0.41	0.45	1.14	2.25	2.71	1.34	1.27	1.05	0.74	0.50	0.45	12.69	1946-1977
Maximum Monthly	1.68	1.01	2.21	3.05	8.23	7.94	3.35	3.55	3.46	2.70	1.19	1.01		1933-1977
Year of Occurrence	(1949)	(1961)	(1950)	(1963)	(1962)	(1964)	(1958)	(1977)	(1951)	(1971)	(1976)	(1977)		
Douglas														
Mean Monthly	.41	.41	.72	1.63	2.18	2.11	1.19	.79	1.08	.79	.58	.39	12.10	1941-1977
Maximum Monthly	1.15	0.81	1.37	4.34	5.08	5.70	4.61	3.25	4.58	2.28	1.29	0.96		1941-1977
Year of Occurrence	(1972)	(1945)	(1944)	(1971)	(1971)	(1967)	(1973)	(1972)	(1942)	(1942)	(1970)	(1945)		

Source: Bureau of Land Management 1980.

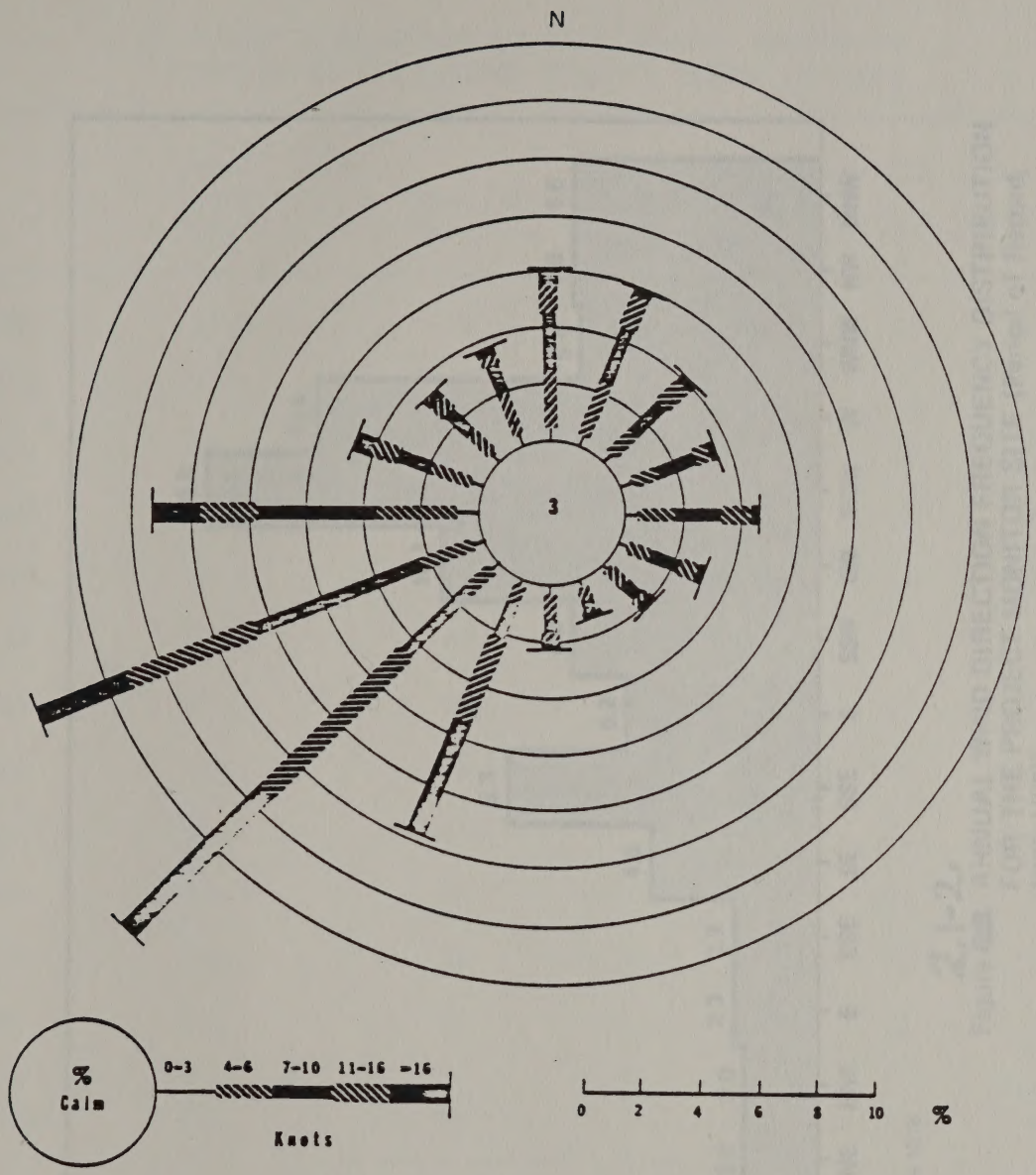
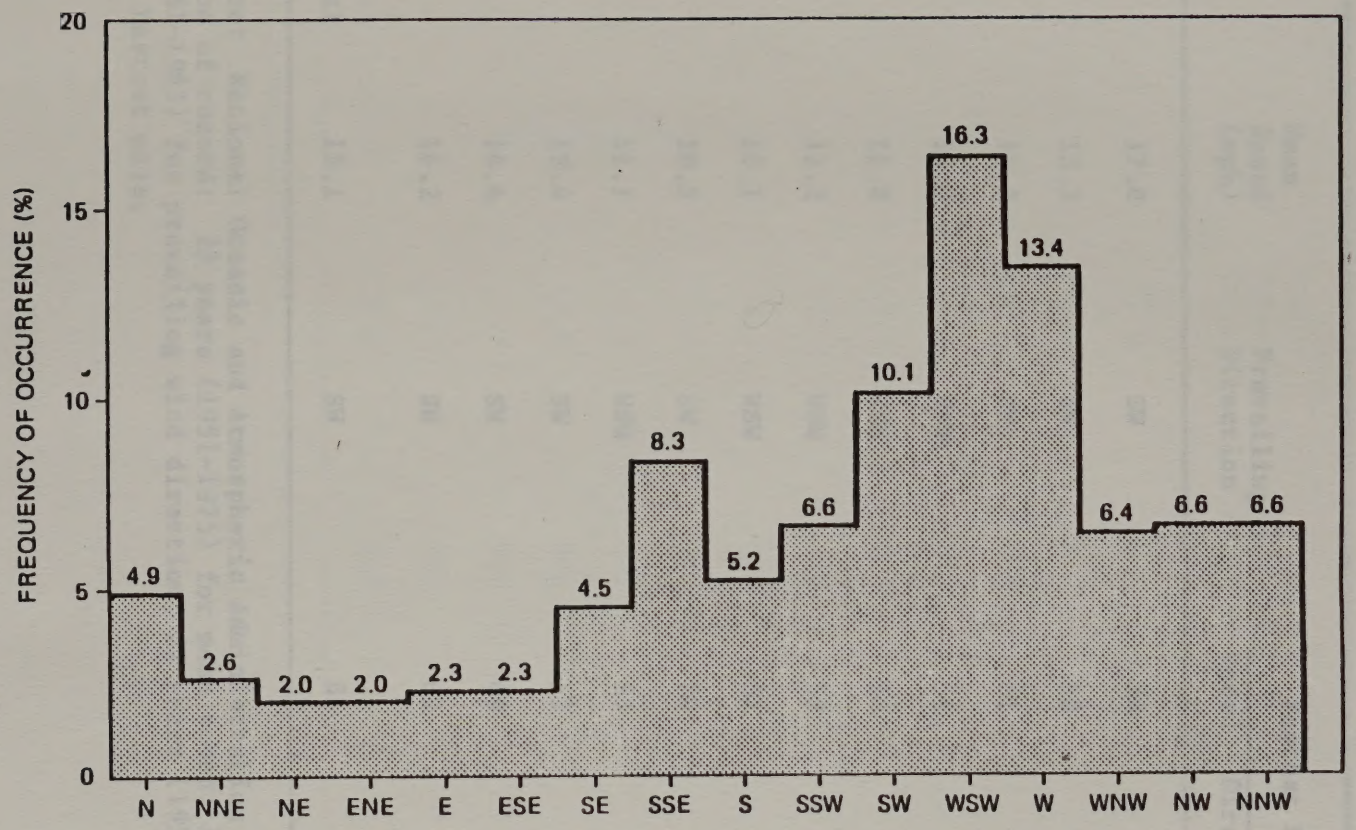


Figure 2.1-1. WIND ROSE FOR CASPER, WYOMING FOR THE PERIOD 1967 THROUGH 1971, ANNUAL AVERAGE CONDITIONS



Source: Metronics 1978

Figure 2.1-2. ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTION FOR THE PROJECT MONITOR SITE (Period of Record, 1975-1978)

TABLE 2.1-3

SUMMARY OF MEAN MONTHLY WIND SPEEDS, PREVAILING DIRECTIONS, AND FASTEST MILES - CASPER, WYOMING

	Mean Speed (mph)	Prevailing Direction	Fastest Mile (mph)		
			Speed	Direction	Year
Jan	17.0	SW	58	20	1954
Feb	15.3	SW	58	23	1957
Mar	14.2	SW	81	25	1956
Apr	13.0	WSW	54	25	1967
May	11.8	WSW	58	32	1959
Jun	11.2	WSW	52	36	1959
Jul	10.1	WSW	52	25	1974
Aug	10.5	SW	50	25	1954
Sept	11.1	WSW	53	32	1965
Oct	12.4	SW	55	25	1954
Nov	14.6	SW	49	25	1970
Dec	16.2	SW	63	20	1955
Annual	13.1	SW	81	25	March 1956

Source: National Oceanic and Atmospheric Administration 1975a.
Period of record: 25 years (1951-1975) for mean speed; 13 years (1951-1963) for prevailing wind direction; 22 years (1954-1975) for fastest mile.

TABLE 2.1-3

SUMMARY OF MEAN MONTHLY WIND SPEEDS, PREVAILING DIRECTIONS, AND VARIOUS MILES - CASPER, WYOMING

	Mean Speed (mph)	Prevailing Direction	Fastest Mile (mph)		
			Speed	Direction	Year
Jan	12.0	SW	76	SW	1954
Feb	13.1	SW	74	SW	1957
Mar	14.2	SW	81	SW	1956
Apr	13.0	SSW	84	SW	1957
May	11.8	WSW	58	SW	1954
Jun	11.2	WSW	52	SW	1952
Jul	10.1	WSW	52	SW	1974
Aug	10.5	SW	50	SW	1954
Sept	11.1	WSW	53	SW	1953
Oct	12.4	SW	55	SW	1954
Nov	14.6	SW	49	SW	1970
Dec	14.2	SW	63	SW	1955
Annual	13.1	SW	81	SW	March 1954

Source: National Oceanic and Atmospheric Administration 1975a.
Period of record: 25 years (1951-1975) for mean speed; 15 years (1951-1965) for prevailing wind direction; 22 years (1954-1975) for fastest mile.

TABLE 2.1-4

SUMMARY OF MEAN MONTHLY WIND SPEEDS AND PREVAILING DIRECTIONS - PROJECT MONITOR SITE

	Mean Speed (mph)	Prevailing Direction
Jan	17.5	W
Feb	19.8	W
Mar	20.3	WSW
Apr	13.7	SW
May	15.9	WSW
Jun	13.9	SE
Jul	15.5	WSW
Aug	13.5	SW
Sept	15.3	SSE
Oct	16.7	WSW
Nov	19.5	WSW
Dec	18.7	WSW
Annual	16.6	WSW

Source: Metronics 1977.

TABLE 2.1-4

SUMMARY OF MEAN MONTHLY WIND SPEEDS AND PREVAILING DIRECTIONS - PROJECT MONITOR SITE

	Mean Speed (mph)	Prevailing Direction
Jan	17.5	S
Feb	15.8	W
Mar	20.3	WSW
Apr	15.7	SW
May	15.9	WNW
Jun	13.9	SE
Jul	13.5	VSW
Aug	13.5	SW
Sept	15.3	SSW
Oct	16.7	VSW
Nov	19.5	VSW
Dec	16.7	WNW
Annual	16.0	VSW

Source: Meteorlix 1977.

Diffusion Climatology. The ability of the atmosphere to disperse air pollutants emitted at a particular location depends on a number of atmospheric variables, the most important of which are stability characteristics, wind direction and speed, mixing depth, and various combinations of these parameters.

Based on the input parameters of solar altitude, cloud cover, ceiling height, and wind speed, D.B. Turner (1964) has classified atmospheric stability into several categories (Pasquill classes) ranging from extremely unstable (A) to extremely stable (G). These criteria have been used by the National Climatic Center to produce STability ARray (STAR) programs, which provide monthly and annual frequency distributions of Pasquill stability classes, wind direction classes, and wind speed classes, for selected long-term meteorological reporting stations. These data are subsequently employed in atmospheric dispersion models to determine pollutant concentrations at various distances from a source (for which the depicted meteorological conditions are representative). Table 2.1-5 summarizes monthly and annual Pasquill stability classes for Casper, based on the National Climatic Center STAR program for July 1967 through December 1971 (National Climatic Center 1973).

The annual distribution of on-site stability data for the proposed site was obtained from the standard deviation of horizontal wind direction, using the methods delineated by Slade (1966) and Irwin (1980). A joint frequency distribution of stability, wind speed, and wind direction for the proposed site is presented in Table 2.1-6.

In general, atmospheric dispersion in the area is good. Good dispersion conditions (Pasquill stability classes A through D) occur about 90 percent of the time and are a result primarily of the clear skies and moderate-to-strong winds that occur there most of the year.

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TABLE 2.1-5

PERCENT MONTHLY FREQUENCY OF PASQUILL STABILITY CLASSES - CASPER, WYOMING, 1967-1971

	Class					
	A	B	C	D	E	F
Jan	0.0	0.1	1.4	84.6	9.8	4.2
Feb	0.0	0.4	2.9	78.3	12.7	5.6
Mar	0.0	1.7	2.7	80.7	10.2	4.6
Apr	0.0	2.4	6.3	70.3	13.3	7.8
May	1.1	4.8	11.0	59.6	12.3	11.2
Jun	1.8	9.0	12.0	47.8	15.2	14.2
Jul	3.5	10.8	14.9	34.4	16.9	19.5
Aug	1.1	11.4	16.5	33.6	17.3	20.2
Sept	0.2	4.6	8.7	52.0	18.9	15.5
Oct	0.0	0.1	4.5	66.9	16.3	11.3
Nov	0.0	0.2	3.0	77.2	12.5	7.2
Dec	0.0	0.0	1.7	82.1	11.9	4.4
Annual	0.7	3.9	7.2	63.9	13.9	10.5

Source: National Climatic Center 1973.

TABLE 2.1-3

PERCENT MONTHLY FREQUENCY OF PASQUILL STABILITY CLASSES -
DARTER, WYOMING, 1967-1971

	Class				
	A	B	C	D	E	F
Jan	0.0	0.1	1.4	84.6	9.8	4.2
Feb	0.0	0.4	2.3	78.7	12.7	5.9
Mar	0.0	1.7	7.7	80.7	10.3	4.6
Apr	0.0	2.4	8.3	76.7	12.3	3.8
May	1.1	4.9	11.0	70.4	12.3	11.2
Jun	1.8	9.0	18.0	47.5	15.2	14.2
Jul	3.5	10.8	14.7	34.4	16.9	17.5
Aug	1.1	11.4	14.5	33.4	17.3	20.2
Sept	0.3	4.8	8.7	32.0	18.0	17.3
Oct	0.0	0.1	9.5	66.9	16.3	11.3
Nov	0.0	0.3	3.0	77.2	12.5	7.3
Dec	0.0	0.0	1.7	82.1	11.9	4.4
Annual	0.7	3.9	7.2	63.9	13.9	10.5

Source: National Climatic Center 1973.

TABLE 2.1-6

PERCENT MONTHLY FREQUENCY OF PASQUILL STABILITY CLASSES - PROJECT MONITOR SITE, 1977 (40-meter level)

	A	B	C	D	E	F	G
Jan	1.7	2.8	5.1	80.6	6.3	3.3	0.0
Feb	2.4	1.6	4.5	84.2	4.9	2.1	0.0
Mar	2.2	2.3	3.1	84.9	2.3	2.5	2.6
Apr	7.3	7.6	6.2	62.1	10.7	6.0	0.2
May	5.2	6.2	11.5	69.9	4.3	2.8	0.0
Jun	7.4	13.8	14.3	55.5	4.2	4.0	0.0
Jul	6.0	10.6	13.4	61.8	4.8	3.2	0.0
Aug	5.8	8.9	10.8	61.6	5.7	7.1	0.0
Sept	6.3	8.0	12.6	61.2	5.2	6.5	0.1
Oct	2.6	2.9	6.7	78.6	6.1	3.1	0.0
Nov	2.8	4.0	6.2	80.8	5.4	0.7	0.0
Dec	3.4	3.3	6.1	78.8	4.6	3.5	0.3
Annual	4.4	6.0	8.4	71.5	5.3	3.8	0.3

TABLE 3.1-6

PERCENT MONTHLY FREQUENCY OF PERCEIVED STABILITY CLASSES -
PROJECT MONITOR SITE, 1977 (40-meter Tower)

	A	B	C	D	E	F	G
Jan	1.7	2.8	3.1	80.0	6.3	3.3	0.0
Feb	2.4	1.6	4.3	84.2	4.4	3.1	0.0
Mar	2.2	3.3	3.1	84.9	2.3	3.5	2.8
Apr	7.3	7.6	5.2	62.1	10.7	6.6	0.3
May	3.2	6.2	11.5	69.9	4.3	2.8	0.1
Jun	7.4	12.3	14.3	52.2	4.2	4.0	0.0
Jul	5.0	10.4	12.4	61.8	4.9	1.3	0.0
Aug	3.8	8.2	10.6	64.4	5.7	7.1	0.0
Sept	6.3	8.2	12.6	61.2	3.2	8.7	0.1
Oct	2.5	2.3	6.7	78.6	6.1	3.1	0.0
Nov	2.4	4.0	8.2	40.6	7.4	8.7	0.0
Dec	3.4	3.3	6.1	78.4	4.4	3.3	0.3
Annual	4.4	6.0	8.4	71.3	5.2	3.8	0.2

Good dispersion conditions for the project site are also indicated by available "mixing depth" data. Mixing depth is a measure of the thickness of the layer of the lower atmosphere in which pollutants can disperse freely after daytime heating burns off the normal nocturnal temperature inversion (stable conditions). Assuming all other conditions are equal, therefore, the higher the afternoon mixing depth, the better the dispersion. Table 2.1-7 presents mixing heights and wind speeds within the mixing layer in the project area.

Air Quality.

General. The proposed plant site is located in an area which is primarily an agricultural and rural region. Existing air quality in the project area is good; the region is currently designated as "Better than National Standards" or "Cannot be Classified" for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), total suspended particulate matter (TSP), ozone (O_3), and carbon monoxide (CO). Federal and Wyoming ambient air quality standards are presented in Table 2.1-8. National primary standards represent the levels necessary, with an adequate margin of safety, to protect the public health. These standards must be attained within 3 years after the state implementation plan is approved by the EPA. National secondary standards are the levels necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Total Suspended Particulate Matter (TSP). TSP is the most extensively monitored pollutant in the area. Three DEQ hi-vol samplers are operated within a 50 km radius of the site with a fourth DEQ hi-vol station that was discontinued in 1975 (the Douglas North site). In addition, private companies operated at least 11 different hi-vol stations for varying periods of time including a WyCoalGas plant site station operated from 1975-78. TSP data collected in the

Good dispersion conditions for the project site are also indicated by available "mixing depth" data. Mixing depth is a measure of the thickness of the layer of the lower atmosphere in which pollutants can disperse freely after daytime heating begins off the normal adjacent temperature inversion (stable conditions). Assuming all other conditions are equal, therefore, the higher the afternoon mixing depth, the better the dispersion. Table 2.1-7 presents mixing heights and wind speeds within the mixing layer in the project area.

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TABLE 2.1-7

ESTIMATED AVERAGE MIXING HEIGHTS AND WIND SPEEDS IN MIXING LAYERS FOR PROJECT SITE AREA

	Mixing Heights (meters)	Wind Speeds (mph)
Annual		
Morning	300	9
Afternoon	2200	15
Winter		
Morning	300	11
Afternoon	1200	13
Spring		
Morning	400	11
Afternoon	2700	17
Summer		
Morning	300	8
Afternoon	3200	15
Autumn		
Morning	250	9
Afternoon	2000	13

Source: Holzworth 1972.

TABLE 2.1-8

FEDERAL AND WYOMING AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Primary Standards[a]		Federal Secondary Standards[a]		Wyoming State Standards[b]	
		$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
Sulfur Dioxide	Annual (Arithmetic)	80	.03			60	.02
	24-hour	365	.14			260	.10
	3-hour			1,300	.5	1,300	.5
Total Suspended Particulate	Annual (Geometric)	75		60		60	
	24-hour	260		150		150	
Carbon Monoxide	8-hour	10,000	9	10,000	9	10,000	9
	1-hour	40,000	35	40,000	35	40,000	35
Photochemical Oxidant (Ozone)	1-hour	235	.12	235	.12	160	.08
Non-Methane Hydrocarbons[c]	3-hour (6-9 a.m.)	160	.24	160	.24	160	.24
Nitrogen Dioxide	Annual	100	.05	100	.05	100	.05
Hydrogen Sulfide	1/2-hour	d	d	d	d	70	d
Fluorides	24-hour	d	d	d	d	0.8	d

Source: Bureau of Land Management 1980.

[a]Title 40 CFR Part 50 National Ambient Air Quality Standards (Standards for averaging times of less than one year are not to be exceeded more than once a year).

[b]Wyoming Ambient Air Quality Regulations, as amended in 1975 (Standards for averaging times of less than one year are not to be exceeded more than once a year).

[c]Standards set as a guide to achieve Photochemical Oxidant Standards.

[d]No standards established.

TABLE 2.1-8

FEDERAL AND WYOMING AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Primary Standards[2] µg/m³	Federal Primary Standards[2] ppm	Federal Secondary Standards[2] µg/m³	Federal Secondary Standards[2] ppm	Wyoming State Standards[3] µg/m³	Wyoming State Standards[3] ppm
Sulfur Dioxide	Annual (Arithmetic)	80	.03			40	.02
	24-hour	365	.14			260	.10
	3-hour			1,300	.5	1,300	.5
Total Suspended Particulate	Annual (Geometric)	75		60		60	
	24-hour	260		150		150	
Carbon Monoxide	8-hour	10,000	9	10,000	9	10,000	9
	1-hour	40,000	35	40,000	35	40,000	35
Photochemical Oxidant (Ozone)	1-hour	235	.12	235	.12	160	.08
Non-Methane Hydrocarbons[5]	3 hour (6-9 a.m.)	160	.24	160	.24	160	.24
Nitrogen Dioxide	Annual	100	.05	100	.05	100	.05
Hydrogen Sulfide	1/2-hour	4	3	4	4	70	3
Fluorides	24-hour	4	4	4	4	0.4	4

Source: Bureau of Land Management 1980.

[1]Title 40 CFR Part 50 National Ambient Air Quality Standards (Secondary for averaging times of less than one year are not to be exceeded more than once a year).

[2]Wyoming Ambient Air Quality Regulations, as amended in 1973 (secondary for averaging times of less than one year are not to be exceeded more than once a year).

[3]Standards are not a guide to achieve photochemical Oxidant Standards.

[4]No standard established.

region are summarized in Table 2.1-9. A more detailed seasonal summary of the 1978 DEQ data is presented in the Meteorology Air Quality and Noise Technical Report (WCC 1981b). The annual concentrations have approached but not exceeded the national secondary and Wyoming standard of 60 $\mu g/m^3$. With the application of particulate matter controls at the power plant in Glenrock, Wyoming, the ambient mean concentration has generally decreased in the area.

Gaseous Pollutants. Monitoring of gaseous pollutants was performed at the proposed plant site from January through June 1974. Within that period, 11 pollutants were monitored, including total hydrocarbons, nonmethane hydrocarbons, methane, nitrogen oxides, NO_2, nitrous oxide, O_3, SO_2, total sulfur compounds, hydrogen sulfide, and CO. The various hydrocarbons, ozone, and oxides of nitrogen were measured during all six months. The sulfur compounds, however, were monitored during May and June. Carbon monoxide was monitored during May. Hourly data listings, equipment description, and calibration information are presented in a report by Metronics (1974).

During the two months monitored, hydrogen sulfide was always below the 0.05 ppm detection limit. The 24-hour mean SO_2 concentration exceeded the detection limit only once during the monitoring period, while total sulfur compound readings were always below the detection limit. Ozone levels reached or exceeded the Wyoming standard of 0.08 parts per million (ppm) during 2 hours of the 6-month sampling period, but most hourly averages showed values of 0.05 ppm or below. Maximum hourly carbon monoxide concentrations (2 ppm) were well below the national and Wyoming standard of 35 ppm, for the one month monitored. Methane levels (for which no national standards have been promulgated) remained steady between 1.2 and 1.3 ppm, with an

TABLE 2.1-9

DAILY MAXIMUM AND ANNUAL GEOMETRIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)-DEQ SITES

Station	Year	No. of Samples	Daily Maximum	Annual Geometric Mean
Burks Ranch	73	55	221	59
	74	52	231	55
	75	58	170	33
	76	57	208	30
	77	52	98	16
	78	27	53	a
Stoddard Ranch	74	44	89	23
	75	23	115	a
Irene Ranch	75	23	82	a
	76	40	105	14
	77	41	152	16
	78	52	118	19
	79	44	137	16
Douglas (north)	77	52	72	11
	78	44	68	14
Douglas	79	30	103	a
Proposed Plant Site	75	52	73	29
	76	55	59	22
	77	60	92	17
	78	52	138	24
Proposed Mine Site	79	23	73	a
	80	51	47	20

Source: Bureau of Land Management 1980.

[a]Number of samples insufficient to compute annual geometric mean.

TABLE 2.1-4

DAILY RAINFAll AND ANNUAL GROWTHLIKE RING FOR CROSS-DATING
(Lyme[1]-Oak Ridge)

Site/Line	Year	No. of Samples	Daily Maximum	Annual Growth Ring
Sawyer Ranch	73	80	321	19
	74	32	244	32
	75	34	130	47
	76	32	324	39
	77	32	98	12
	78	37	53	4
Sandhaus Ranch	74	44	94	22
	77	33	112	4
Lemon Ranch	73	32	92	4
	74	42	183	14
	77	41	153	24
	78	34	219	12
	79	44	197	14
Douglas (Lower)	77	32	72	11
	78	40	98	14
Douglas	79	32	109	4
Wyandot Lake Tree	73	32	72	14
	74	32	52	12
	77	34	85	13
	78	35	124	24
Fourteen Mile Site	77	32	74	4
	78	34	42	14

Source: Dunham of Lake Erie Environment (1980).

[1]Number of samples lost/illegible to compute annual growth ring mean.

hourly maximum of 1.7 ppm. The monthly average concentration of nonmethane hydrocarbons ranged from 0.5 to 1.8 ppm, with a 3.2 ppm maximum.

From October 1976 to November 1978 a trailer with continuous monitoring instruments was operated by the DEQ at the plant monitor site. Sulfur dioxide, nitrogen dioxide, and ozone were monitored. The monitors for sulfur dioxide and nitrogen dioxide were activated in October 1976. Ozone monitoring was begun in August 1977. The NO_2 monitor was discontinued in March 1978, while SO_2 and O_3 monitoring was discontinued in November 1978.

The observed values for sulfur dioxide and nitrogen dioxide from 1976 through 1978 are typical of a rural environment and far below the national standards for each pollutant. Peak hourly SO_2 concentrations observed during 1976, 1977, and 1978 were 0.03 ppm, 0.05 ppm, and 0.04 ppm, respectively.

The DEQ ozone monitoring record for 1977 indicates that one hourly ozone concentration (0.11 ppm) exceeded the 0.08 ppm standard and one concentration equaled it. Overall, however, more than 99 percent of the recorded hours had concentrations less than 0.05 ppm. The 1978 ozone record shows 90 percent of the readings to be 0.05 ppm, with a maximum of 0.07 ppm. The mean concentration of each year was 0.03 ppm. These results are quite similar to those observed at the same site in 1974.

Noise. No noise measurements are available for the project area. Existing noise levels in the region are expected to be the result of natural sources, because of the rural, undeveloped nature of the

project region. Based on studies done by the EPA (1974), existing noise levels are expected to be about 40 to 45 decibels, L_{dn} scale.

Mine Site

Climate. Climatic conditions at the proposed mine site are similar to these presented for the plant. There are no significant terrain features separating the two sites. Mine site-specific meteorological data are being collected at the proposed North Antelope mine site, approximately one-half mile west of the proposed Rochelle mine.

As in the case of the proposed plant site, annual average temperature is about 45°F based on data from Rochelle and Dull Center (U.S. Weather Bureau 1965). The coldest month is January and the warmest is July.

Annual precipitation at the mine site is expected to be about 10 to 13 inches. Snowfall data taken at Rochelle (National Oceanic and Atmospheric Administration 1975b), at an elevation of 4,496 feet, indicate that annual average snowfall is about 34 inches.

Wind speed and direction data presented for the plant site are expected to be fairly representative of the mine site, although local topographic features would be expected to affect the wind characteristics at a specific site.

Air Quality. Total suspended particulate matter (TSP) has been monitored at the mine site during the last half of 1979 and all of 1980. The annual mean TSP concentration is about 20 $\mu g/m^3$; the maximum 24-hour average concentration observed during the period was 73.4 $\mu g/m^3$.

Gaseous pollutant levels are expected to be similar to those discussed for the proposed plant site.

Noise. No noise measurements have been taken at the proposed mine site. Because of the rural nature of the location, existing noise levels are expected to be about 40 to 45 decibels, L_{dn} scale.

Other Project Components

For other project components, climate, air quality, and noise conditions are expected to be similar to those discussed for the proposed plant site.

2.2 TOPOGRAPHY, GEOLOGY, GEOLOGIC HAZARDS, AND PALEONTOLOGY

Topography

The proposed project area lies within the Great Plains physiographic province, the topography of which is relatively subdued. However, topographic relief of several hundred feet occurs in the basins, and relief in uplift areas exceeds 1,000 feet.

Within the Powder River Basin, where the entire project except a part of the product pipeline would be located, the landscape consists principally of broad valleys and scattered low hills; in the southern basin this terrain gives way to conspicuously eroded badlands. The major streams in the Powder River Basin are entrenched 200 to 400 feet.

The product pipeline would extend across the Hartville Hills, a local geologic uplift with approximately 1,500 feet of topographic relief. These hills are dissected by numerous intermittent streams in narrow gulches or broad valleys. South of the Hartville Hills the pipeline would cross the Denver Basin, which is gently rolling with moderate relief. There are several escarpments, the most prominent of which is the Goshen Hole escarpment, approximately 500 feet high. The product pipeline would cross it in two places.

Geology

Stratigraphy. Geologic units ranging in age from Precambrian to Holocene would be occupied by various components of the proposed project. Brief lithologic descriptions of the geologic units exposed at the surface are presented in Table B-1 in Appendix B; their stratigraphic relationships are shown in Figure 2.2-1.

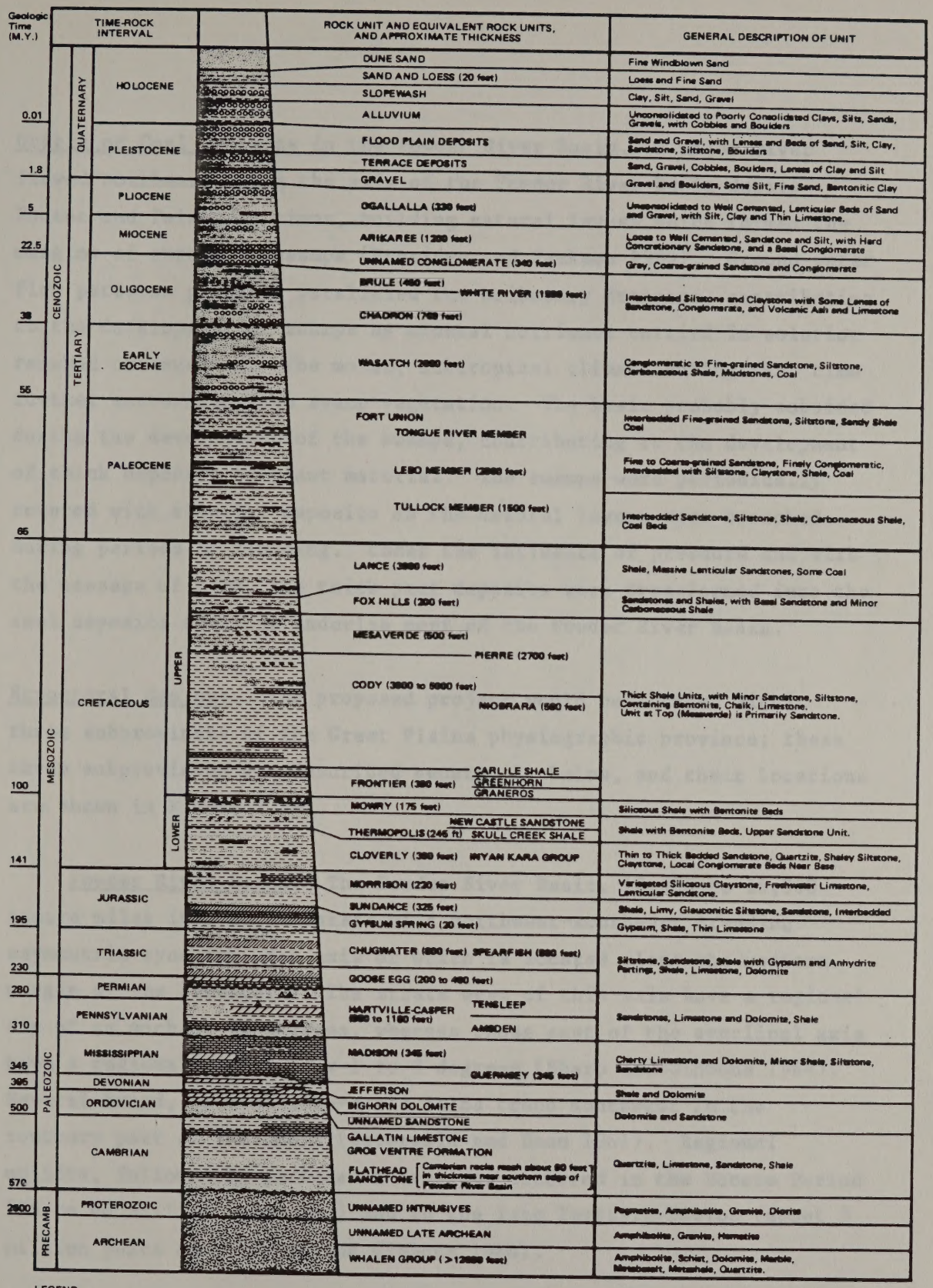

Figure 2.2-1
COMPOSITE STRATIGRAPHIC COLUMN FOR THE WYCOALGAS PROJECT

Origin of Coal Deposits in the Powder River Basin. A major river flowed northward along the axis of the Powder River Basin during Eocene and Paleocene times, building natural levees which formed the margins of extensive swamps (Ethridge and Jackson 1980). Ground-water flow patterns probably paralleled the tributary drainage, contributing to the development of swamps as mineral nutrients carried in solution reached the surface. The moist, subtropical climate during that time further encouraged lush swamp vegetation. The basin probably subsided during the development of the swamps, contributing to the development of thick deposits of plant material. The swamps were periodically covered with alluvial deposits as the natural levees were breached during periods of flooding. Under the influence of pressure and with the passage of time, the thick peat deposits were transformed into the coal deposits that now underlie most of the Powder River Basin.

Structural Geology. The proposed project would be located within three subprovinces of the Great Plains physiographic province; these three subprovinces are described separately below, and their locations are shown in Figure 2.2-2.

Powder River Basin. The Powder River Basin, 12,000 to 15,000 square miles in area, consists of a northwest-southeast trending asymmetric syncline, the axis of which is located along the western margin of the structure. The strata west of this axis have a regional dip of as much as 20 degrees, whereas those east of the synclinal axis have a regional dip of only 1 to 2 degrees (Sharp and Gibbons 1964). Several broad, intermediate-scale folds trend southwest in the southern part of the basin (Osterwald and Dean 1961). Regional uplifts, followed by periods of erosion, occurred in the Eocene Period (55 to 40 million years ago) and in the late Tertiary Period (about 5 million years ago) (Sharp and Gibbons 1964).

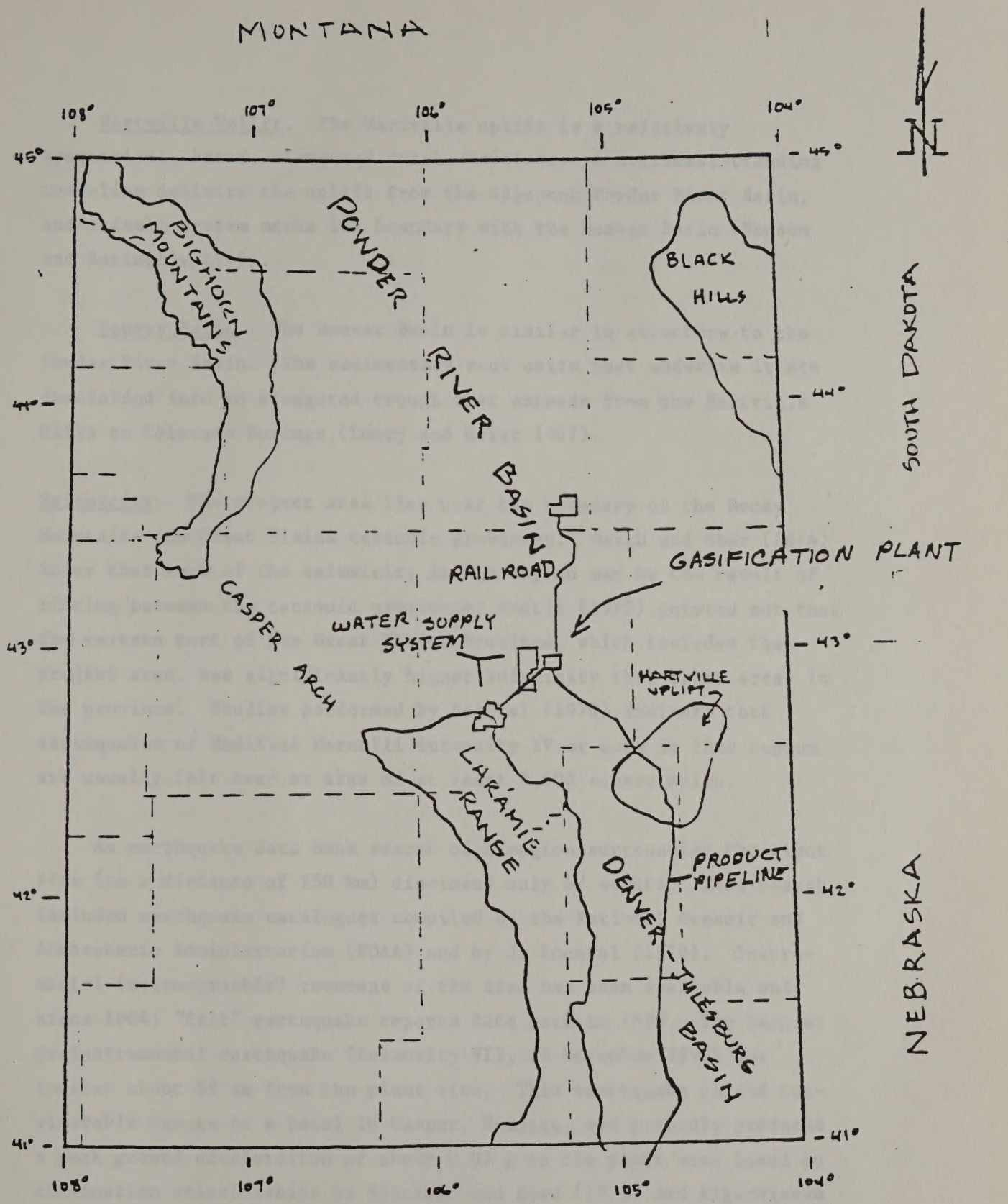

FIGURE 2.2-2 COLORADO

MAJOR PHYSIOGRAPHIC FEATURES IN THE PROJECT AREA

0 50 100 MILES

Hartville Uplift. The Hartville uplift is a relatively symmetrical, broad, elongated domal structure. A northeast-trending monocline delimits the uplift from the adjacent Powder River Basin, and a fault system marks its boundary with the Denver Basin (Denson and Botinelly 1949).

Denver Basin. The Denver Basin is similar in structure to the Powder River Basin. The sedimentary rock units that underlie it are downfolded into an elongated trough that extends from the Hartville Hills to Colorado Springs (Lowry and Crist 1967).

Seismicity. The project area lies near the boundary of the Rocky Mountains and Great Plains tectonic provinces. Smith and Sbar (1974) infer that much of the seismicity in the region may be the result of rifting between the tectonic provinces; Nuttli (1973) pointed out that the western part of the Great Plains Province, which includes the project area, has significantly higher seismicity than other areas in the province. Studies performed by Docekal (1970) indicate that earthquakes of Modified Mercalli intensity IV or more in this region are usually felt over an area of at least 1,500 square miles.

An earthquake data bank search of a region surrounding the plant site (to a distance of 250 km) disclosed only 67 events. This search included earthquake catalogues compiled by the National Oceanic and Atmospheric Administration (NOAA) and by J. Docekal (1970). Instrumental (seismographic) coverage of the area has been available only since 1964; "felt" earthquake reports date back to 1895. The largest preinstrumental earthquake (Intensity VII, 14 November 1897) was located about 89 km from the plant site. This earthquake caused considerable damage to a hotel in Casper, Wyoming, and probably produced a peak ground acceleration of about 0.03 g in the plant area based on attenuation relationships by Schnabel and Seed (1973) and Algermissen

and Perkins (1976). The closest preinstrumental earthquake was located 82 km from the site, and probably produced an insignificant ground acceleration at that location. Instrumentally recorded earthquakes in the area studied have all had magnitudes less than 5.0, and most have occurred in the Rocky Mountains more than 100 km from the plant site. The exceptions include a magnitude 4.5 earthquake and a magnitude 3.0 aftershock, which occurred 42 km from the plant site on August 22, 1964. The spatial relationships can be inferred to suggest that they occurred on the Rawhide fault. The larger of these two events probably caused a peak ground acceleration of about 0.02 g at the plant site, based on the attenuation relationshiops cited above. No earthquakes are known to have occurred in closer proximity to the plant site than these two events. Studies performed by Algermissen and Perkins (1976) indicate that earthquakes of magnitude 7.0 could occur in the project region. Nuttli (1973) suggests that the recurrence interval for maximum earthquakes in this region may be about 1,000 years.

Paleontology. The available data appear to indicate that nearly every geologic unit in the project region is fossiliferous (see Table 2.2-1). However, only two reported fossil localities are present in the vicinity of any of the proposed facilities. Both of these vertebrate fossil localities are within T. 17 N., R. 66 W. in Laramie County. "Joe's Quarry," in sec. 21, is located a few hundred feet west of the proposed product pipeline alignment, near milepost 117. "Horse Creek Quarry," in sec. 3, is located about 1 mile east of the proposed right-of-way. The stratigraphy and paleontology of both of these localities have been described by Cassiliano (1976) in a thesis entitled "Stratigraphy and Paleontology of the Horse Creek - Trail Creek Area, Laramie County, Wyoming," submitted to the Department of Geology at the University of Wyoming, Laramie, Wyoming. The fossils

TABLE 2.2-1

INFERRED FAULT CROSSINGS PROPOSED PRODUCTS PIPELINE

Approximate Milepost[a]	Location Description	Fault Name	Relative Displacement	Data Source
58.7	Whalen Canyon T. 27 N., R. 65 W., sec. 17, 20	Sunrise	Down to W. left lateral[b]	Snyder 1980 Denson and Botinelly 1949
65.9	Near Laramie River T. 26 N., R. 65 W., sec. 29	Wheatland	Down to NW[c]	McGrew 1963
66.4	Near Laramie River T. 26 N., R. 65 W., sec. 29	Wheatland	Down to NW[c]	McGrew 1963
69.8	T. 25 N., R. 65 W., sec. 8, 17	Whalen	Down to SE[d]	McGrew 1963
71.2	T. 25 N., R. 65 W., sec. 20	Whalen	-	McGrew 1963
72.4	T. 25 N., R. 65 W., sec. 29	Whalen	Down to NW[d]	McGrew 1963 McGrew 1967

[a]The mapped locations may not be sufficiently accurate for design purposes.

[b]Minimum displacement across Sunrise fault is 300 feet (Denson and Botinelly 1949).

[c]Minimum displacement across Wheatland system is 650 feet (McGrew 1963).

[d]Minimum displacement across Whalen system is 600 feet (McGrew 1963).

[a] Hitchcock locations may not be exactly accurate for specific backwater.

[b] Minimum displacement assumed approximately equal to 450 tons (Jackson and Porterfield 1964).

[c] Minimum displacement assumed approximately equal to 450 tons (Jackson and Porterfield 1964).

[d] Minimum displacement assumed approximately equal to 450 tons (Jackson 1964).

Hitchcock[a] Photomosaic	Location Description	Name Annie	Displacement Estimated	Source Date
25.1	Airlies Landing I' 10 N'' E' 23 N'' 2001' 15' 30	Sportsman	Down to A^{*}	Gunther 1980
25.2	Mouth Lamoine River I' 35 E'' E' 53 N'' 2001' 35	Aphrodite	Down to BM_{c}	Accsen 1981
25.4	Near Lamoine Island I' 32 E'' E' 53 N'' 2001' 35	Aphrodite	Down to BM_{c}	Accsen 1981
25.5	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981
25.6	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981
25.7	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981
25.8	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981
25.9	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981
25.10	Lamoine Beach I' 32 E'' E' 53 N'' 2001' 15' 30	Aphrodite	Down to AA_{d}	Accsen 1981

INFERRED AREAS CROSSING RECORDED BACKWATER ATTRITION

TABLE 3.5-1

found in the above-named quarries included fish, turtles, birds, horses, rhinoceri, camels, antelope, and deer.

Geologic Hazards.

Seismic Hazards. An earthquake with a recurrence interval of 1,000 years would be the maximum credible event for the project region, based on relationships presented by Nuttli (1973) and Algermissen and Perkins (1976), and would produce an acceleration of 0.5 g at 10 kilometers from epicenter. Such an acceleration could cause substantial damage to structures and, under certain conditions, liquefaction or other types of ground failure. However, a less conservative interpretation of the recurrence data of Algermissen and Perkins (1976) indicates a 90 percent probability that an acceleration of 0.04 g would not be exceeded in 50 years. The most probable location of a future, strong earthquake in the project region would appear to be the active faults mentioned below. However, the possibility of other source locations cannot be precluded, as the historic seismicity of the region has been quite diffuse; there has been no clear, consistent relationship of epicenters to known faults.

Surface fault rupture is a potentially severe problem for structures astride active faults. The proposed product pipeline would cross an extension of the Rawhide fault and several traces of the Wheatland-Whalen fault system, both of which have been classified as active (Witkind 1975). McGrew (1981) reports the presence of a wide gouge zone, where a fault trace related to the latter fault system displaces 8,000-year-old sediments; this condition suggests repeated episodes of surface fault rupture during Holocene time. The approximate fault crossing locations are listed in Table 2.2-1.

Landslides. Studies in the Powder River Basin by the USGS (Miller 1978) show that many landslides occur on slopes underlain by

poorly consolidated sand-shale sequences within the Fort Union and Wasatch formations, causing damage to facilities or presenting a potential hazard during construction. Most occur on slopes steeper than 14 degrees (31 percent), but large landslides have occurred on slopes as gentle as 11 degrees (24 percent) (Ebaugh 1978). Plastic soils and water from local aquifers or melting snow are cited as common contributory factors to slope instability (Chleborad 1978). Ground water has also been cited as a factor in failures of high walls in open-pit mines (McGregor et al. 1978). However, Savage and Smith (1978) concluded that the most critical factor in the stability of high walls appears to be the degradation of strength and deformation properties of exposed rock with time after excavation.

Other Geologic Problems. Some soils found in arid areas can "collapse" as a result of denser packing when wetted, especially under a load. The volume of the soil may decrease about 10 to 15 percent and, depending upon the thickness of the deposit and the depth of penetration of the water, the ground surface may sink several feet. Shelton and Prouty (1979) present several examples from Colorado, including one in which the settlement amounted to 8 feet. Dudley (1970) presents detailed technical information on this phenomenon. Bentonitic soils and rocks can generate high swelling pressures when wetted, sometimes causing severe structural damage (Shelton and Prouty 1979). Soils in both these categories have been identified at the proposed plant site (Woodward-Thorfinnson 1974).

2.3 SOILS

Soils in the WyCoalGas project area were formed on three general types of parent material (Hilston et al. 1977). North of Douglas, Wyoming, soils in the project area were formed in calcareous, Quaternary, loamy alluvium or residuum derived from Tertiary sandstones and clay shales. In the South Well Field and along the water pipeline corridor south of the North Platte River, the parent material is calcareous, loamy or skeletal, Quaternary residuum or colluvium derived from Tertiary sandstones and clay shales. Soil parent material in the project area south of Douglas to the southern terminus of the product pipeline is calcareous, skeletal or loamy, Quaternary alluvium or residuum derived from Tertiary tuffaceous sandstones, clay shales, and marlstones.

Soils that will be directly disturbed by major project components are listed in Table C-1 in Appendix C. These soils can be classified as very young Torrifluvents, young Torriothents, more mature, weakly developed Camborthids, and mature, well developed Arguistolls and Haplargids.

Mine

Most of the soils on the proposed mine site have a loamy surface texture, are well drained, and have a moderate to severe erosion hazard (Peters and Andrews 1980). Soil reaction or pH values range from a favorable range for vegetation growth. Soil salinity on the mine site is generally not a significant problem for vegetation growth. Soil on less than 5 percent of the site may have relatively high salinity.

According to the Land Capability Classification used by the U.S. Soil Conservation Service (SCS 1979), approximately 30 percent of the

mine site has soil suitable for cropland but with severe to very severe limitations or erosion hazards (Peters and Andrews 1980). Less than 20 percent of the site may be suitable for irrigation, and there are no prime farmland soils. The remaining 70 percent of the mine site has soils that should be used for grazing and forestry.

It is estimated that over 60 percent of the site has no topsoil suitable for use in reclamation (Peters and Andrews 1980). Where suitable soils do exist, topsoil depths range from 3 to 60 inches and average approximately 27 inches (Peters and Andrews 1980).

Railroad

Most of the soils in the railroad corridor have a surface texture of loam, sandy loam, or clay loam (SCS undated, Northern Converse County Soil Survey). Approximately 95 percent of these soils are well drained, less than 4 percent are excessively drained, and less than 1 percent are poorly or somewhat poorly drained. Soil pH ranges from 6.1 to 9.0, with most profiles ranging from 6.6 to 8.4 (SCS undated, Northern Converse County Soil Survey). This is a favorable range for vegetation growth. Soil salinity is not high enough to restrict plant growth along approximately 70 percent of the corridor. Soils in the rest of the corridor may have salinity values greater than 8 mmhos/cm, which only a few native plant species tolerate.

Soils in approximately 50 percent of the corridor are marginally suitable for use as cultivated cropland with a Land Capability Classification of 4 (SCS undated, Northern Converse County Soil Survey). The major limitation of soils in this class is erosion hazard. The remaining 50 percent of the land is suitable only for use as rangeland and/or wildlife habitat with Capability Classes of 6 through 8. There are no prime farmland soils in the corridor (SCS undated, Prime Farmland, North Converse County).

More than 55 percent of the soils in the railroad corridor are suitable for use in reclamation. Topsoil stripping depths range from 3 to 60 inches. The major factors limiting the reclamation use of the remaining soils include high salinity, sodicity, depth to bedrock, and sandy texture.

Plant

Soils on the proposed plant site have a surface texture of loam, clay loam, or sandy loam with a pH ranging from 6.6 to 8.4 (SCS undated, Northern Converse County Soil Survey). The soils have electrical conductivity values of less than 2 mmhos/cm, indicating a very low salt content. The water erosion hazard for these soils is severe (SCS undated, Northern Converse Soil Survey). The wind erosion hazard ranges from moderate to high but is commonly moderate.

None of the soils on the plant site are suitable for use as cultivated cropland but they are suitable for rangeland or wildlife habitat (SCS undated, Prime Farmland, North Converse County).

Essentially all of the soils on the plant site are suitable for use in reclamation. Topsoil stripping depths range from 15 to 30 inches or to bedrock, whichever occurs first.

Water Supply System

Combs Reservoir. The three soils that occur on the proposed reservoir site have surface textures of fine sandy loam, clay loam, and loam (SCS 1965-1980). All of these soils are well drained. They have a moderate to severe water erosion hazard and a moderate to high wind erosion hazard (SCS 1965-1980).

The pH of the soils ranges from 6.1 to 9.0 (SCS 1965-1980), which is a suitable range for plant growth. Soil salinity is generally low, with electrical conductivity values ranging from 0 to 8 mmhos/cm (SCS 1965-1980).

Less than 10 percent of the soils on the reservoir site are suitable for use as cultivated cropland and there are no prime farmland soils in the area. The remaining soils on the site are suitable for use as rangeland and wildlife habitat (SCS undated, Prime Farmland, North Converse County).

All of the soils are suitable for use in reclamation. Topsoil stripping depths are approximately 6 inches.

North Well Field. Most of the soils in the proposed North Well Field have surface textures of loam, clay loam, or sandy loam (SCS undated, Northern Converse County Soil Survey). Approximately 95 percent of the soils are well drained and the remaining soils are excessively drained.

Soil pH ranges from 6.1 to 9.0 (SCS 1965-1980; SCS undated, Northern Converse County Soil Survey). Soil salinity is generally low. Less than 5 percent of the soils may have high salinity levels. Severe water and wind erosion could be expected from soils covering 40 to 50 percent of the well field. The water and wind erosion hazards on the rest of the area are moderate.

Less than 10 percent of the soils in the North Well Field are suitable for cultivated cropland. Factors limiting soils for this use are erosion hazard, shallow topsoil depth, and clayey textures. There are no prime farmland soils in the area (SCS undated, Prime Farmland, Northern Converse County). Approximately 90 percent of the soils in the well field are suitable for rangeland and wildlife habitat.

Approximately 70 percent of the soils in the well field are suitable for use in reclamation. Topsoil stripping depths range from 3 to 60 inches.

South Well Field. Soils in the proposed South Well Field generally have surface textures of very fine sandy loam, silt loam, and loam (SCS 1965-1980). All of the soils are well drained.

Soil pH ranges from 6.1 to 9.0 (SCS 1965-1980). Soil salinity is generally very low.

All of the soils in the well field are suitable for use as rangeland and/or wildlife habitat. There are no prime farmland soils in the area. None of the soils are suitable for use in reclamation.

Water Pipeline. Soils in the water pipeline corridor have surface textures of silt loam, fine sandy loam, and loam. These soils have a pH ranging from 6.1 to 9.0. Soil salinity is generally low. The water and wind erosion hazards of the soils in the corridor are generally moderate to severe.

Due to the high erosion hazard, less than 15 percent of the soils in the corridor are suitable for use as cultivated cropland. Approximately 85 percent of the soils are suitable for use as rangeland and wildlife habitat. There are no prime farmland soils in the area (SCS undated, Northern Converse County Soil Survey).

All of the soils in the water pipeline corridor are suitable for use in reclamation. Topsoil stripping depths range from 0 to 60 inches.

Product Pipeline

Most of the soils in the proposed product pipeline corridor have a loamy surface texture (SCS undated, Platte, Eastern Laramie, and Southern Converse Counties Soil Surveys). Approximately 70 percent of these soils are well drained, less than 2 percent are poorly drained, and the remaining soils are moderately excessive to excessively drained.

Soil pH ranges from 6.1 to 9.0. The electrical conductivity of most soils in the corridor is less than 2 mmhos/cm, indicating very low salt content (SCS 1965-1980). The water and wind erosion hazards of these soils are typically moderate (SCS undated, Eastern Laramie and Northern Weld Counties Soil Surveys; SCS 1965-1980).

Approximately 40 percent of the soils in the pipeline corridor are suitable for use as cultivated cropland with Land Capability Classes of 2 through 4 (SCS undated, Platte, Eastern Laramie, and Southern Converse Counties Soil Surveys). Factors limiting the agricultural use of these soils include erosion hazard, water availability, and climate. There are no prime farmland soils in the area. The remaining soils in the pipeline corridor are suitable for use as rangeland and wildlife habitat, with Capability Classes of 6 through 8.

Approximately 35 percent of the soils in the pipeline corridor are suitable for use in reclamation. Topsoil stripping depths for these soils range from 21 to 60 inches.

Produce Pipeline

Most of the soils in the proposed product pipeline corridor have a loamy surface texture (SCS unpublished, Platte, Eastern Lancaster, and Southern Converse Counties Soil Surveys). Approximately 70 percent of these soils are well drained, less than 2 percent are poorly drained, and the remaining soils are moderately excessive to excessively drained.

Soil pH ranges from 6.1 to 7.8. The electrical conductivity of most soils in the corridor is less than 2 mmhos/cm, indicating very low salt content (SCS 1963-1980). The water and wind erosion hazards of these soils are typically moderate (SCS unpublished, Eastern Lancaster and Northern Weld Counties Soil Surveys; SCS 1963-1980).

Approximately 40 percent of the soils in the pipeline corridor are suitable for use as cultivated cropland with land capability Classes of 2 through 4 (SCS unpublished, Platte, Eastern Lancaster, and Southern Converse Counties Soil Surveys). Factors limiting the agricultural use of these soils include erosion hazard, water availability, and climate. There are no prime farmland soils in the area. The remaining soils in the pipeline corridor are suitable for use as rangeland and wildlife habitat, with capability Classes of 5 through 8.

Approximately 35 percent of the soils in the pipeline corridor are suitable for use in reclamation. Topsoil stockpiling depths for these soils range from 21 to 60 inches.

2.4 HYDROLOGY AND WATER QUALITY

Surface Water

Mine.

Drainage Basins. The Rochelle Mine permit area is drained primarily by tributaries of Porcupine Creek and Beckwith Creek, as shown in Figure 2.4-1. Porcupine Creek lies to the southwest of the mine area, and Beckwith Creek lies east of the mine area. Approximately 0.17 square mile of the northeastern part of the mine area is drained by School Creek. The northwestern portion of the mine area contains two closed drainage basins encompassing 2.1 square miles. Sunny Draw drains 0.04 square mile in the southeastern part of the mine area. Porcupine Creek, Beckwith Creek, and Sunny Draw are tributaries of Antelope Creek, which is a tributary of the Dry Fork of the Cheyenne River. School Creek is a tributary of Little Thunder Creek, which in turn is a tributary of Black Thunder Creek. All of these streams are in the Cheyenne River drainage basin.

The present morphology of the Rochelle Mine permit area is dominated by the headward erosion of the tributaries of Porcupine Creek and Beckwith Creek into the relatively flat-lying Wasatch and Fort Union formations. The northwestern part of the permit area is a relatively flat plateau, but the eastern and southern edges of the permit area are deeply incised by the headward-cutting tributaries. The drainage basins within the area have a dendritic pattern and are elongate in shape. First- and second-order stream channels predominate at a scale of 1:24,000. The small tributaries of Beckwith and Porcupine creeks have channel slopes ranging from 60 to 233 feet per mile. Drainage density in the permit area is about 3 miles of stream length per square mile. Various parameters indicative of the quantitative

2.4 HYDROLOGY AND WATER QUALITY

Surface Water

Mine

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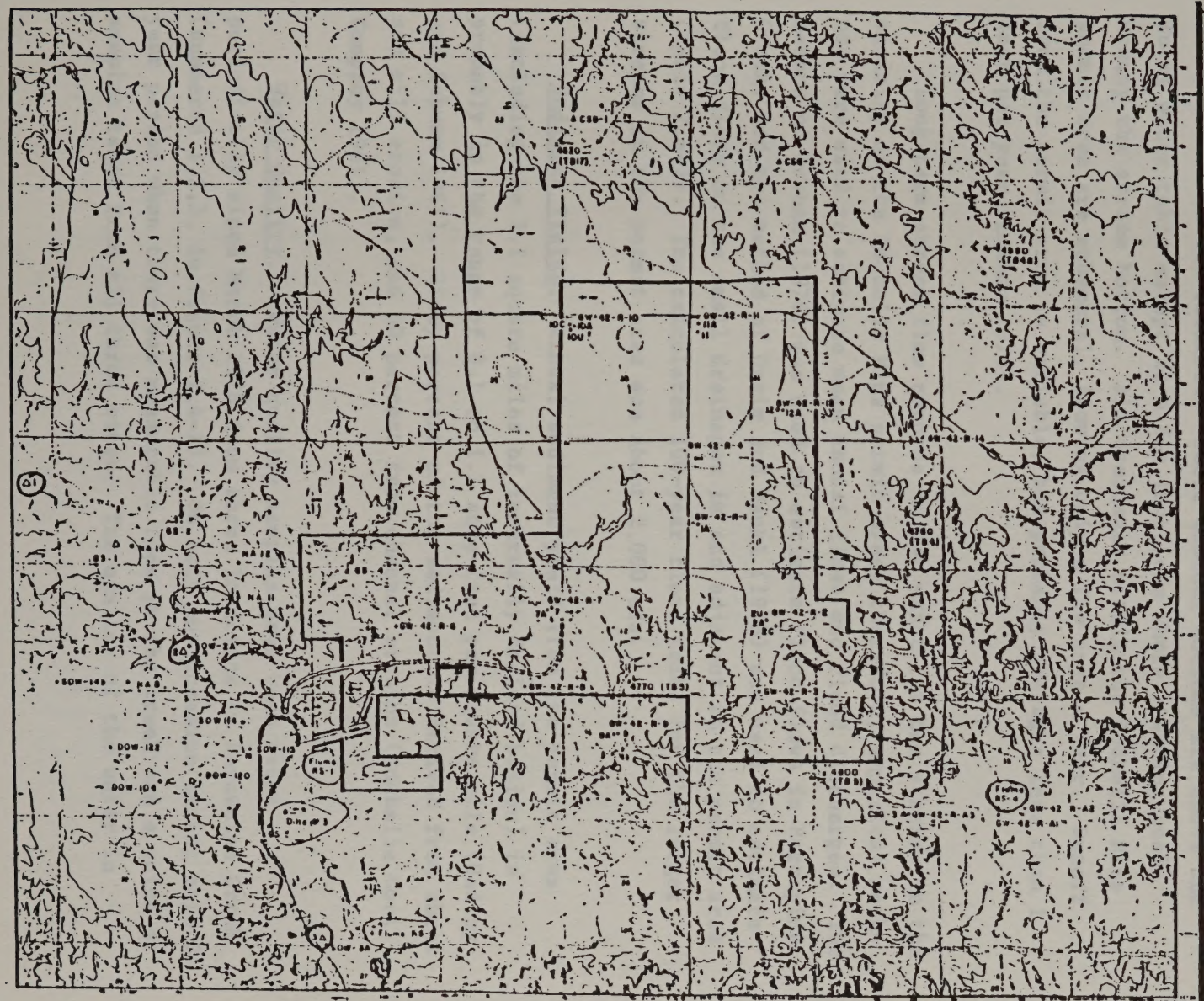
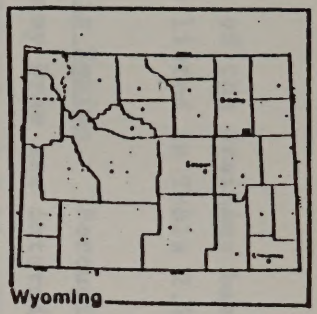


Rochelle Coal Company

Rochelle Mine
PERMIT AREA
12015 East 46th Ave.
Denver, Colorado 80239



Legend
- Permit boundary
- Flume site
- Crest stage gage
- Monitor well
- Flowing well
- Spring

C.I. = 10' & 20'

Scale ½ 0 Miles

North

HYDROLOGY MONITORING SITES

Design by: WATEC, Inc.
Drawn by:
Checked by:
Revisions:

Date: 3/9/80
Sheet of
Figure

FIGURE 2.4-1

geomorphology of the drainage basins in the vicinity of the Rochelle Mine area are listed in Table 2.4-1.

Hydrologic Regime. Porcupine Creek, Beckwith Creek, School Creek, and Sunny Draw are intermittent, flowing only for short periods due to snowmelt and rainfall. Their channel bottoms are above the local water table except at a few locations where standing pools occupy the stream bottom. All drainages within the Rochelle Mine permit area are ephemeral, flowing only a few days a year. Runoff from the permit area is variable, but probably averages less than 1 inch per year (Lowham 1976).

Long-term stream flow records do not exist for the streams in the vicinity of the Rochelle Mine permit area; therefore, empirical methods were used to estimate mean annual flows and flood discharges. The method of Lowham (1976) was used to estimate flood flows in Porcupine Creek; and the method of Craig and Rankl (1978) was used to estimate flood flows on the small drainages in and adjacent to the permit area (Table 2.4-2). The calculated 100-year flood peaks for the larger streams in the permit area are about 2,000 cfs.

Sediment Yields. Annual sediment yield from the permit area (excluding the 2.1 square miles of internally drained basins) is probably in the range of 0.1 to 1.1 acre-feet per square mile (Hadley and Schumm 1961). Sixty percent of the sediment is derived from sheet and sill erosion, and 40 percent from channel erosion (Rochelle Coal Company 1981).

Water Quality. Water quality samples have been taken periodically since March 1978 from three locations in Porcupine Creek (numbered 1,2,3, in Figure 2.4-1). On only one occasion during this 2-year period when there was measurable flow in the creek was a suite of samples taken from all three sites. The quality of the water in

TABLE 2.4-1

GEOMORPHIC CHARACTERISTICS OF DRAINAGE BASINS IN AND ADJACENT TO THE ROCHELLE COAL MINE

Drainage[a]	Area (mi^2)	Basin Slope[b] (ft/mile)	Main Channel[c] Slope (ft/mi)	Total Stream[d] Length (mi)	Drainage[e] Density (mi^{-1})	Channel[f] Maintenance (mi^2/mi)	Sinuosity
Beckwith Creek above flume RS-4	6.28	724	69	22.2	3.5	.29	1.3
No. 3 Draw above flume RS-5	7.27	746	58.6	25.2	3.5	.29	1.4
No. 3 Draw in permit area	3.31	451	60	7.8	2.3	.43	1.2
Knapp Draw in permit area	4.06	401	93	14.7	3.6	.28	1.4
No. 2 Draw above flume RS-1	2.39	593	95	6.5	2.7	.37	1.3
Tributary School Creek in permit area	.17	700	166	0.3	1.8	.56	1.1
Beckwith Creek tributaries in permit area							
No. B1	.27	555	214	0.6	2.2	.45	1.1
No. B2	.91	350	134	2.1	2.3	.43	1.2
No. B2	.51	784	213	2.2	4.3	.23	1.3
No. B3	.44	708	233	.8	1.8	.56	1.3
No. B4	.25	400	161	.6	2.4	.42	1.4

[a]The location of the drainages are shown on Figure 2.4-1.
[b]Basin slope is the average slope in the drainage basin.
[c]Main channel slope is the average slope of channel between points 10% and 85% of the distance along the channel from the measuring point to the drainage divide.
[d]Drainage density is total stream length in basin divided by basin area.
[e]Channel maintenance in the drainage area per mile of stream length.
[f]Sinuosity is the ratio of stream length to valley length.

TABLE 2.4-2

CALCULATED FLOOD FLOWS FOR THE DRAINAGES IN AND ADJACENT TO THE ROCHELLE COAL MINE

	Area	Mean Annual Flow (cfs)	Peak Flows of Various Recurrence Intervals (cfs)[1]					
			2 year	5 year	10 year	25 year	50 year	100 year
Porcupine Creek at mouth[a]	125	6.7 (1.4)[b]	533	1,433	2,536	4,428	6,386	8,833
Beckwith Creek at RS-4[b]	6.3		440	1,100	1,700	2,200	3,000	4,200
Tributary No. B2 at permit boundaries[b]	0.91		210	375	600	800	940	1,250
No. 3 Draw at RS-5[b]	7.27		580	1,100	1,800	2,300	3,000	4,000
No. 3 Draw at permit boundary[b]	3.31		300	600	900	1,400	1,700	2,000
No. 2 Draw at RS-1	2.39		275	550	800	1,300	1,700	2,000
Knapp Draw at northern permit boundary	1.77		410	760	1,000	1,600	2,000	2,600
Knapp Draw at western permit boundary	4.06		380	770	1,300	1,800	2,000	2,800

[a]Porcupine Creek flows calculated using method of Lowham (1976); all other flows calculated using method of Craig and Rankl (1978).

[b]Based on relationship between unit runoff and drainage area developed by Hadley and Schumm (1961) for the upper Cheyenne River basin.

Porcupine Creek on this date (July 9, 1980) improved in a downstream direction (Table 2.4-3). The total dissolved solids concentrations changed from 1,211 mg/l at the upstream site, to 342 mg/l at site no. 2, to 252 mg/l at the downstream site. The water type changes from a calcium sodium sulfate type at the upstream site to a calcium bicarbonate type at the downstream site. At the upstream site the water was suitable for stock watering and marginally suitable for irrigation; at the downstream site it was suitable for all domestic and stock uses.

Water quality samples have been collected only once in the Beckwith Creek drainage because flow has been infrequent since the monitoring program began in June 1979. Samples were taken during snowmelt on February 11, 1980 at sampling site RS-4 on the main channel of Beckwith Creek and at monitoring site CSG-3 on a tributary of Beckwith Creek (Table 2.4-3). The sampled waters were a calcium sulfate type, of medium salinity.

Downstream from the mine, Antelope Creek is intersected by Porcupine Creek. Since 1977 the USGS has maintained a gaging station and collected water samples for chemical analysis from a point 0.4 mile downstream from the confluence with Porcupine Creek. The results of selected water quality analyses for this station are listed in Table 2.4-3. This water is a mixed cation sulfate type, of medium salinity. The predominant cations are calcium, sodium, and magnesium, in that order. Water quality at this point is adequate for stock watering, but in most cases would require careful management practices if applied to agricultural lands. Trace element content is low.

Forrquina Creek on this date (July 9, 1980) improved in a downstream direction (Table 2.4-3). The total dissolved solids concentrations changed from 1,311 mg/l at the upstream site, to 342 mg/l at site no. 2, to 522 mg/l at the downstream site. The water type changes from a calcium sodium sulfate type at the upstream site to a calcium bicarbonate type at the downstream site. At the upstream site the water was suitable for stock watering and marginally suitable for irrigation; at the downstream site it was suitable for all domestic and stock uses.

Water quality samples have been collected only once in the Redwith Creek drainage because flow has been infrequent since the monitoring program began in June 1979. Samples were taken during snowmelt on February 11, 1980 at sampling site S2-4 on the main channel of Redwith Creek and at sampling site C3-1 on a tributary of Redwith Creek (Table 2.4-3). The sampled waters were a calcium sulfate type, of medium salinity.

Downstream from the mine, Antelope Creek is intersected by Forrquina Creek. Since 1977 the USGS has maintained a gauging station and collected water samples for chemical analysis from a point 2.4 mile downstream from the confluence with Forrquina Creek. The results of analyzed water quality samples for this station are listed in Table 2.4-3. This water is a mixed cation sulfate type, of medium salinity. The predominant cations are calcium, sodium, and magnesium. In that order. Water quality at this point is adequate for stock watering, but in most cases would require natural management practices if applied to agricultural lands. Trace element content is low.

TABLE 2.4-3

SURFACE WATER QUALITY IN THE VICINITY OF THE ROCHELLE COAL MINE PERMIT AREA

	Porcupine Creek[a] (July 9, 1980)			Beckwith Creek[a] (February 11, 1980)		Antelope Creek[b] near Teckla		
	Site 1	Site 2	Site 3	RS-4	CSG-3	Average	Min	Max
Conductivity	1,386	482	359	638	773	2,150	435	2,650
Total dissolved solids	1,211	342	252	742	892	1,670	292	2,120
Total suspended solids	1	8	15	57	48	128	5	1,130
pH	7.3	7.0	7.7	7.4	7.8	--	7.9	8.3
Total alkalinity	173	60	144	86	117	310	56	440
Total hardness	--	--	--	396	566	850	--	1,200
Calcium	185	42	24	83	143	230	33	300
Magnesium	56	19	26	41	45	31	13	110
Sodium	41	12	9	43	22	190	28	280
Potassium	25	13	13	14	17	14	5	21
Iron (dissolved)	.07	.34	.24	.08	.08	.05	0.0	0.34
Manganese (dissolved)	.02	.03	.04	.2	.2	.17	.003	.57
Bicarbonate	173	60	144	136	184	370	68	540
Sulfate	728	173	47	388	458	940	150	1,200
Chloride	3	3	3	5	4	16	4	31
Fluoride	.08	.56	.54	.37	.40	.54	.2	1.1
Boron	.87	.06	.05	.46	.80	.18	.05	.54
Cadmium	.01	.01	.01	.002	0.0	--	--	--
Selenium	.001	.001	.001	.001	.001	--	--	--

Sources: [a]Rochelle Coal Company 1981.
[b]U.S. EPA STORET Retrieval 1981.

TABLE C.4-3

SURFACE WATER QUALITY IN THE VICINITY
OF THE MOSSBLUFF COAL MINE FEBRUARY 1980

	Surrounding Areas[a] (July 4, 1980)			Backbone Creek[b] (February 11, 1980)			Adjacent Areas[a] Non Toxic	
	Site 1	Site 2	Site 3	Site-4	Site-5	Average	Min	Max
Conductivity	1,180	422	329	418	773	1,225	445	2,676
Total dissolved solids	1,211	242	222	342	493	1,870	272	3,128
Total suspended solids	1	8	15	31	44	240	3	2,434
pH	7.3	7.0	7.1	7.4	7.5	—	7.9	8.1
Total alkalinity	171	80	144	84	117	144	58	448
Total hardness	—	—	—	176	346	678	—	1,104
Calcium	185	42	34	83	124	320	24	340
Magnesium	34	15	28	41	43	31	13	130
Sodium	41	12	7	42	32	180	32	240
Potassium	13	43	13	14	17	14	7	12
Iron (dissolved)	.07	.34	.32	.00	.02	.25	0.0	0.34
Manganese (dissolved)	.02	.03	.00	.1	.2	.17	.013	.27
Bicarbonate	171	80	144	102	142	370	44	548
Sulfate	718	173	67	143	203	898	142	1,300
Chloride	3	3	3	3	4	14	4	31
Fluoride	.08	.36	.34	.03	.03	.34	.3	1.1
Boron	.07	.06	.05	.04	.04	.14	.08	.34
Cadmium	.01	.01	.01	.002	0.0	—	—	—
Selenium	.001	.001	.000	.003	.003	—	—	—

Sources: [a]Southern Coal Company 1980.
[b]U.S. EPA STORET Retrieval 1981.

North Platte River.

Past and Present Water Use.

Irrigation and power production are the main uses of North Platte River water. Approximately 810,000 acres of land are irrigated in the North Platte River basin above Lake McConaughy, excluding the Laramie River basin (Figure 2.4-2). Of this total, 356,000 acres are in Wyoming, 319,000 are in Nebraska, and 135,000 are in Colorado (U.S. Bureau of Reclamation 1957). Approximately 230,000 acres in the Platte River valley below Lake McConaughy are irrigated from the North Platte River (Nebraska Department of Water Resources 1980).

Total consumptive use of North Platte River water in Wyoming has been estimated to be about 588,000 acre-feet per year (Wyoming State Engineer's Office 1971), of which irrigation consumes about 574,000 acre-feet, industrial uses about 9,000 acre-feet, and domestic and municipal uses about 5,000 acre-feet.

Irrigation in the North Platte River basin began about 1865 in eastern Wyoming and western Nebraska. By 1910 all of the dependable natural flow of the North Platte River and its tributaries was used in valleys suited to irrigation; in fact, the natural flow was overappropriated on many streams.

Two large irrigation projects built by the U.S. Bureau of Reclamation (the North Platte Project and the Kendrick Project) have been responsible for most of the increases in irrigated acreage since 1910 in the North Platte River basin above Lake McConaughy. The North Platte Project, which began operation in 1909 with the completion of the Pathfinder Reservoir, provides irrigation water directly to about 235,000 acres in Nebraska and 90,000 acres in Wyoming. In addition, about 80,000 acres irrigated by canals diverting between Tri-State Dam

North Platte River.

Past and Present Water Use.

Irrigation and power production are the main uses of North Platte River water. Approximately 410,000 acres of land are irrigated in the North Platte River basin above Lake McConaughy, excluding the Laramie River basin (Figure 2.4-1). Of this total, 335,000 acres are in Wyoming, 319,000 are in Nebraska, and 145,000 are in Colorado (U.S. Bureau of Reclamation 1977). Approximately 250,000 acres in the Platte River valley below Lake McConaughy are irrigated from the North Platte River (Nebraska Department of Water Resources 1980).

Total consumptive use of North Platte River water in Wyoming has been estimated to be about 500,000 acre-feet per year (Wyoming State Engineer's Office 1971), of which irrigation consumes about 374,000 acre-feet, industrial uses about 8,000 acre-feet, and domestic and municipal uses about 3,000 acre-feet.

Irrigation in the North Platte River basin began about 1863 in eastern Wyoming and western Nebraska. By 1910 all of the depredable natural flow of the North Platte River and its tributaries was used in valleys suited to irrigation; in fact, the natural flow was overappropriated on many streams.

Two large irrigation projects built by the U.S. Bureau of Reclamation (the North-Platte Project and the Kendrick Project) have been responsible for most of the increases in irrigated acreage since 1910 in the North Platte River basin above Lake McConaughy. The North Platte Project, which began operation in 1909 with the completion of the Pathfinder Reservoir, provides irrigation water directly to about 235,000 acres in Nebraska and 20,000 acres in Wyoming. In addition, about 80,000 acres irrigated by canals diverting between Tri-State Dam

PLATTE RIVER DRAINAGE BASIN IN COLORADO, WYOMING, AND NEBRASKA

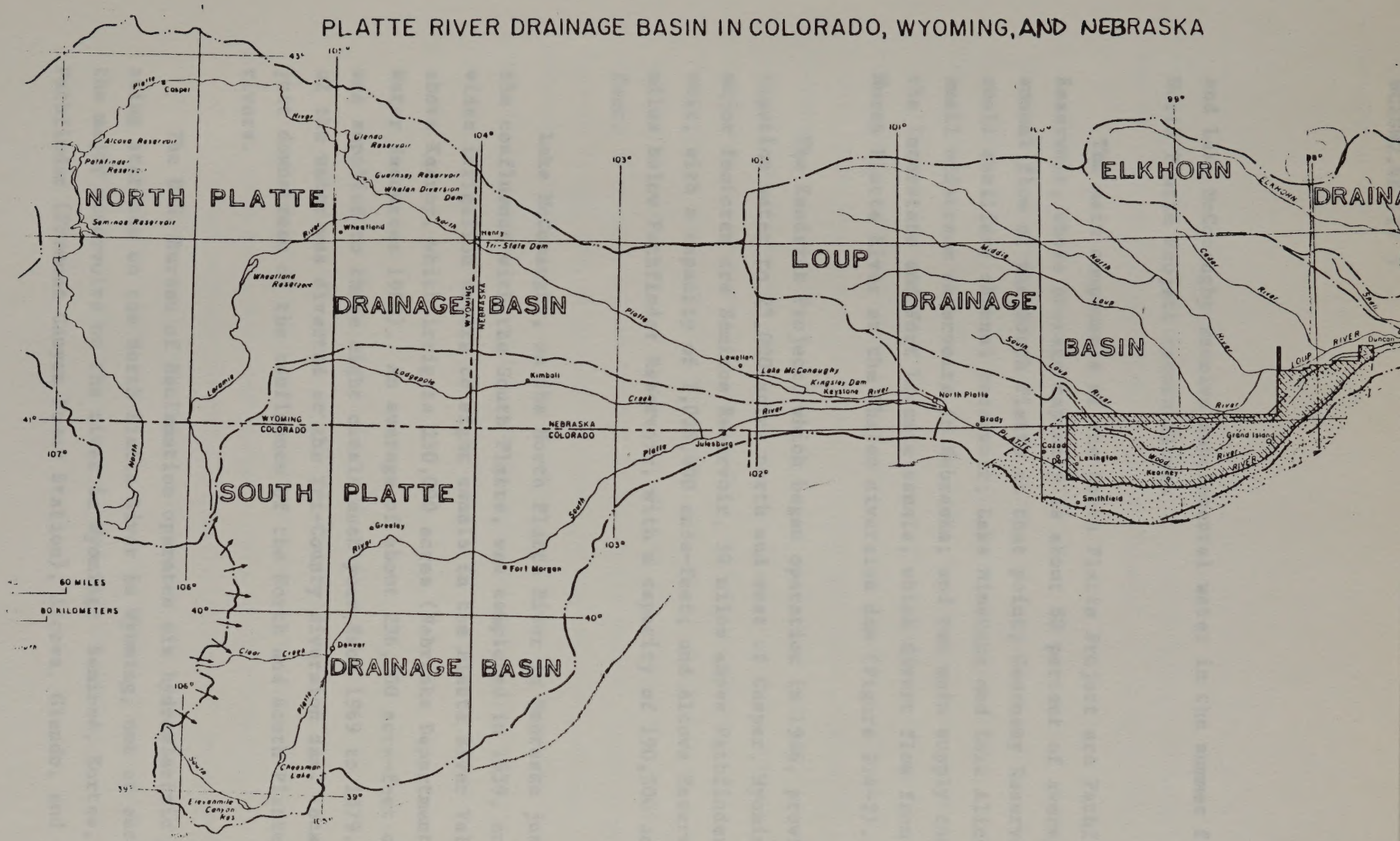


FIGURE 2.4-2

and Lake McConaughy receive supplemental water in the summer from North Platte Project return flows.

The main components of the North Platte Project are Pathfinder Reservoir, whose storage capacity is about 80 percent of average annual flow of the North Platte at that point; Guernsey Reservoir, a small auxiliary channel reservoir; Lake Minatare and Lake Alice, two small offstream reservoirs in Nebraska; and two main supply canals, the Interstate and Fort Laramie canals, which divert flow from the North Platte River at the Whalen diversion dam (Figure 2.4-2).

The Kendrick Project, which began operation in 1946, provides irrigation water to 23,000 acres north and west of Casper, Wyoming. Its major features are Seminoe Reservoir, 30 miles above Pathfinder Reservoir, with a capacity of 1,026,400 acre-feet; and Alcova Reservoir, 13 miles below Pathfinder Reservoir, with a capacity of 190,500 acre-feet.

Lake McConaughy, on the North Platte River in Nebraska just above the confluence with the South Platte, was completed in 1939, and provides irrigation waters to eight canals in the Platte River Valley above Kearny, which irrigate 230,000 acres (Nebraska Department of Water Resources 1980). An average of about 236,000 acre-feet of water was supplied to these eight canals each year from 1969 to 1979. Most of the water was diverted at the Tri-County diversion dam, located just downstream of the confluence of the North and South Platte rivers.

The U.S. Bureau of Reclamation operates six hydroelectric generating stations on the North Platte River in Wyoming, one at each of the major reservoirs on the river in Wyoming: Seminoe, Kortes, Pathfinder (Fremont Canyon Power Station), Alcova, Glendo, and

Guernsey. The generating stations have a total installed capacity of 181 MW, and an average annual power production of about 90 MW.

River Operation. The North Platte River in Wyoming is operated by the U.S. Bureau of Reclamation under the supervision of the Wyoming Board of Control. The river system is generally operated by two sets of rules based on the North Platte River Decree of 1945, as amended in 1953. The first set of rules are reservoir operation criteria based on the physical limits of the reservoirs, the needs of downstream areas, consideration of the Bureau of Reclamation's Western Division hydroelectric operations, and experience gained through past operation. The second set of rules are the legally-derived ownership accounting procedures that determine distribution of the natural flow, restrictions on irrigation delivery, and amount of ownership stored in the reservoirs. Daily records are kept by the Bureau of Reclamation and the Wyoming Board of Control of reservoir levels, river flows, natural flows, and diversions, as well as ownership accounting. In Nebraska, the North Platte and Platte rivers are operated by the Nebraska Department of Water Resources. The general pattern of operation for the reservoirs on the North Platte System is as follows:

- Seminoe Reservoir (1,016,746 acre-feet active storage). The typical operation is to retain as much water in storage as possible during the summer and to evacuate the reservoir during the fall and winter. This procedure serves to: ensure maximum reservoir capacity to control spring and summer runoff, generate power during the fall and winter, and retain the reservoir at its fullest storage capacity during summer months for fishing and recreation.

- Pathfinder Reservoir (1,015,888 acre-feet of active storage). The typical operation is to lower Pathfinder Reservoir to a minimum by the end of September and then to increase storage capacity during the fall and winter until approximately 100,000 acre-feet of storage capacity is available for spring runoff. Releases from Pathfinder Reservoir are used to maximize power generation and to meet downstream water demands in coordination with Glendo Reservoir releases.

- Alcova Reservoir (188,783 acre-feet active storage). Alcova Reservoir is kept nearly full during the irrigation season, because the water level in the reservoir must be in the top 10 feet to make deliveries to the Casper Canal for the Kendrick Project. About 70,000 acre-feet per year are diverted for irrigation of Kendrick Project lands. Gray Reef Dam, below Alcova, serves only to reregulate releases from upstream facilities.

- Glendo Reservoir (506,425 acre-feet active storage). The operation of Glendo Reservoir usually involves the transfer of about half of the storage water ownership from Pathfinder Reservoir (North Platte Project ownership) to Glendo Reservoir during the fall and winter. Releases from Glendo Reservoir during the irrigation season generate power and meet downstream water demands. At the end of the irrigation season, the reservoir content is usually at minimum storage. Generally, there are no releases downstream during October to February, except seepage. Release starts in March to refill Guernsey to the power head prior to release to Lake Alice and Lake Minatare.

* Parkfinder Reservoir (1,015,638 acre-feet of active storage). The typical operation is to lower Parkfinder Reservoir to a minimum by the end of September and then to increase storage capacity during the fall and winter until approximately 100,000 acre-feet of storage capacity is available for spring runoff. Releases from Parkfinder Reservoir are used to maximize power generation and to meet downstream water demands in coordination with Olympia Reservoir releases.

* Alcova Reservoir (128,787 acre-feet active storage). Alcova Reservoir is kept nearly full during the irrigation season, because the water level in the reservoir must be in the top 10 feet to make deliveries to the Casper Canal for the Kendrick Project. About 70,000 acre-feet per year are diverted for irrigation of Kendrick Project lands. Gray Reef Dam, below Alcova, serves only to regulate releases from upstream facilities.

* Olmedo Reservoir (508,438 acre-feet active storage). The operation of Olmedo Reservoir usually involves the transfer of about half of the storage water overnight from Parkfinder Reservoir (North Platte Project generally) to Olmedo Reservoir during the fall and winter. Releases from Olmedo Reservoir during the irrigation season generate power and meet downstream water demands. At the end of the irrigation season, the reservoir content is usually at minimum storage. Generally, there are no releases downstream during October to February, except emergency. Releases starts in March to refill Guernsey to the water head prior to release to Lake Alice and Lake Minatare.

- Guernsey Reservoir (45,228 acre-feet of active storage). Guernsey Reservoir operations are basically for the reregulation of releases made from upstream reservoirs to meet irrigation requirements within the North Platte project area. Periodically since 1936, water in the reservoir has been evacuated rapidly during July and early August to flush accumulations of sediment into the irrigation distribution system. This is believed to stabilize canal banks and reduce canal and lateral seepage losses. Nine miles below Guernsey Reservoir is the Whalen diversion dam, where about 762,000 acre-feet per year are diverted into the Fort Laramie and Interstate canals for the North Platte Project.

- Lake McConaughy (2,000,000 acre-feet of storage). Lake McConaughy is operated by the Central Nebraska Public Power and Irrigation District, unlike the Wyoming reservoirs which are operated by the U.S. Bureau of Reclamation. The normal operation of Lake McConaughy results in a minimum reservoir level at the conclusion of the irrigation season. Releases are usually curtailed in early fall so that only sufficient water to meet downstream power generation commitments is released. Downstream of Lake McConaughy at Keystone Dam, an average of about 725,000 acre-feet per year are diverted to the Sutherland Canal; this water is stored in Sutherland and Maloney reservoirs before being used to generate power at the North Platte plant of the Nebraska Public Power District, and is returned to the South Platte River just west of the confluence with the North Platte River. Just downstream from the confluence of the North and South Platte rivers, the Tri-County diversion dam diverts an average of about 300,000 acre-feet for irrigation in the Platte River valley.

An operation model of the North Platte River system above Tri-State Dam has been developed by the Wyoming Water Resources Research Institute (Wei 1977; Akerbergs 1980, 1981). This model, which simulates the actual operation of the river system described above, is essentially a set of algorithms that mimic the rules used in operating the river. The model has been shown to simulate quite well the actual river operations during the period 1968 to 1980.

Hydrologic Regime. Stream flows on the North Platte River are regulated by the seven federal reservoirs in Wyoming, Lake McConaughy in Nebraska, and extensive diversions for irrigation, power production, and industrial uses in the basin. Natural flow conditions have not prevailed in the North Platte River system since before 1865, when the first irrigation diversions were constructed.

Flow regulation in the North Platte River for irrigation and power production has had a dramatic effect on the flow regime of the North Platte and Platte rivers. Figure 2.4-3 shows mean annual discharge near Glenrock, Wyoming, at the Nebraska-Wyoming border, and at North Platte and Overton, Nebraska. Mean annual discharge at the downstream stations in Nebraska today are only about 10 to 20 percent of flows prior to completion of Pathfinder Reservoir in 1909; the average annual flow at North Platte, Nebraska, was about 2,000,000 acre-feet prior to 1910, and the annual average flow today is about 450,000 acre-feet. The Wyoming State Engineer (1971) estimated that the annual average flow of the North Platte River at the state line has declined from 1,743,000 acre-feet to 980,000 acre-feet, a decrease of 44 percent.

Flow regulation has not only decreased annual flows in the river, it has also changed the seasonal distribution of flows in the river.

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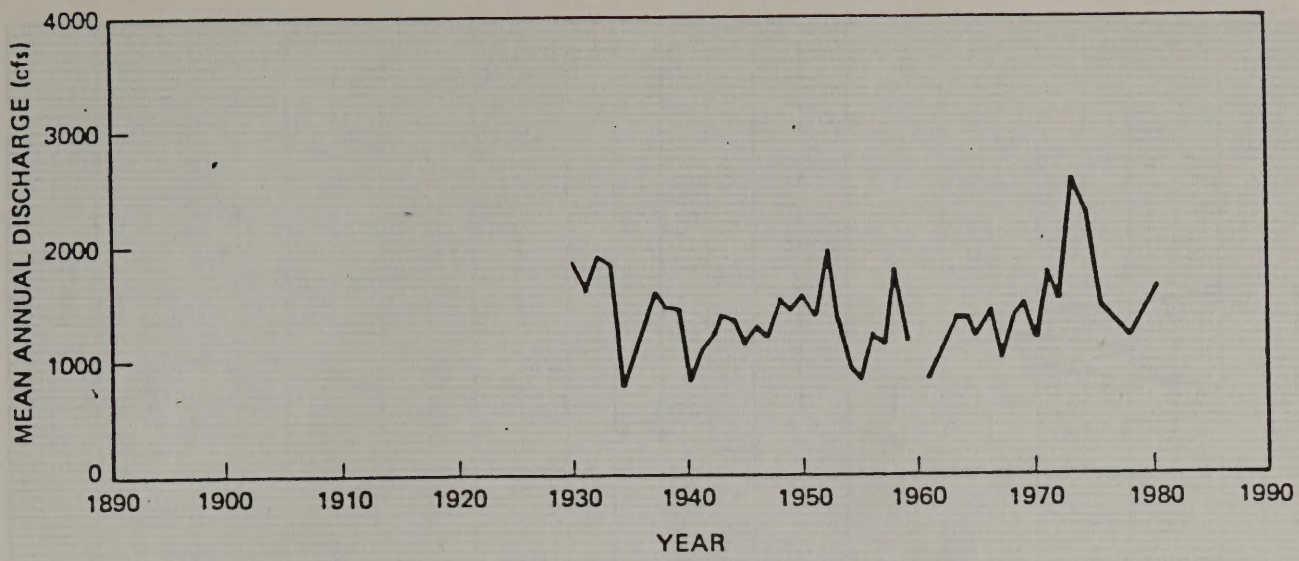


FIGURE 2.4-3a
MEAN ANNUAL DISCHARGE OF NORTH PLATTE RIVER
NEAR DOUGLAS (1930-1959) AND GLENROCK (1961-1980).

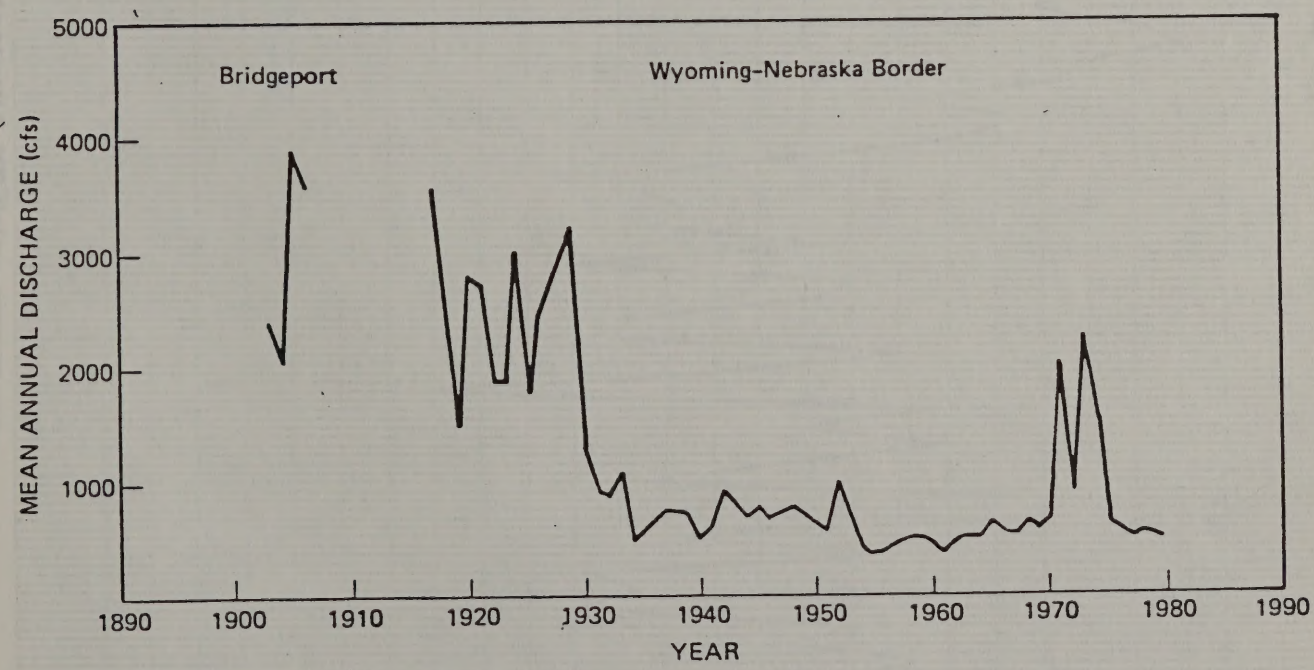


FIGURE 2.4-3b
MEAN ANNUAL DISCHARGE OF NORTH PLATTE RIVER
AT BRIDGEPORT (1903-1929) AND WYOMING-NEBRASKA
BORDER (1930-1979)

FIGURE 2.4-3 b
MEAN ANNUAL DISCHARGE OF NORTH PLATTE RIVER
NEAR DOUGLAS (1920-1959) AND GLENROCK (1951-1980).

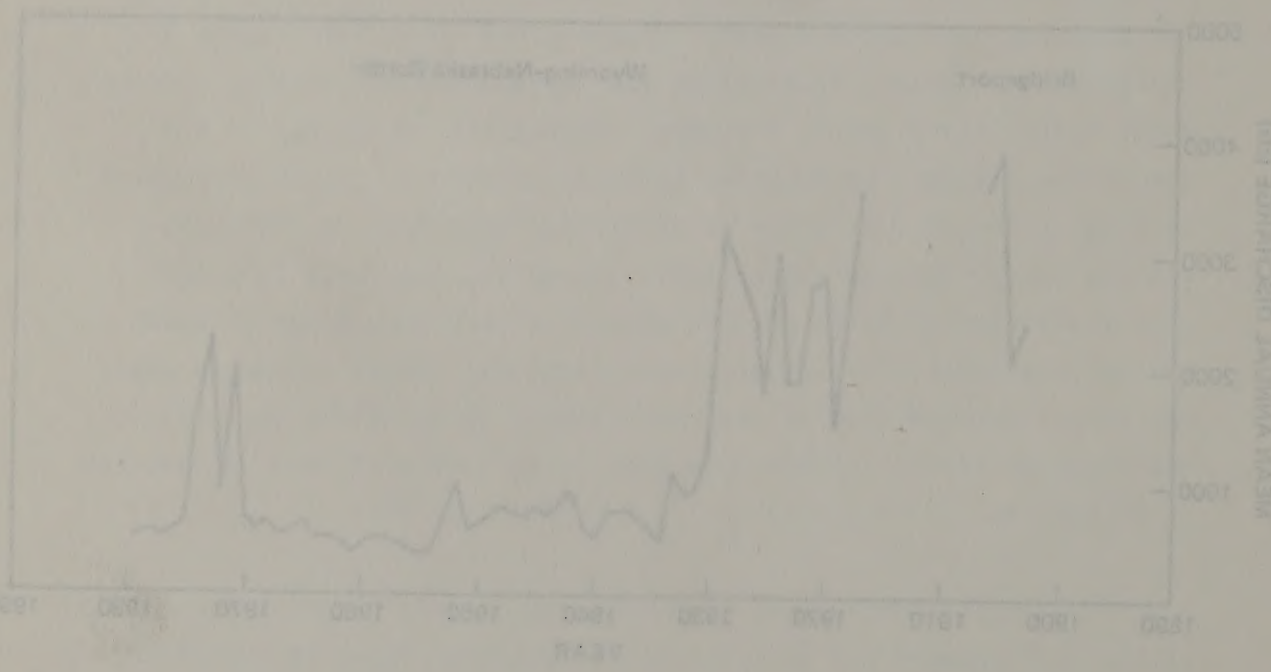


FIGURE 2.4-3 b
MEAN ANNUAL DISCHARGE OF NORTH PLATTE RIVER
AT BRIDGEPORT (1903-1972) AND WYOMING-NEBRASKA
BORDER (1930-1972)

Figure 2.4-3c

North Platte River at North Platte
Mean Annual Discharge of the

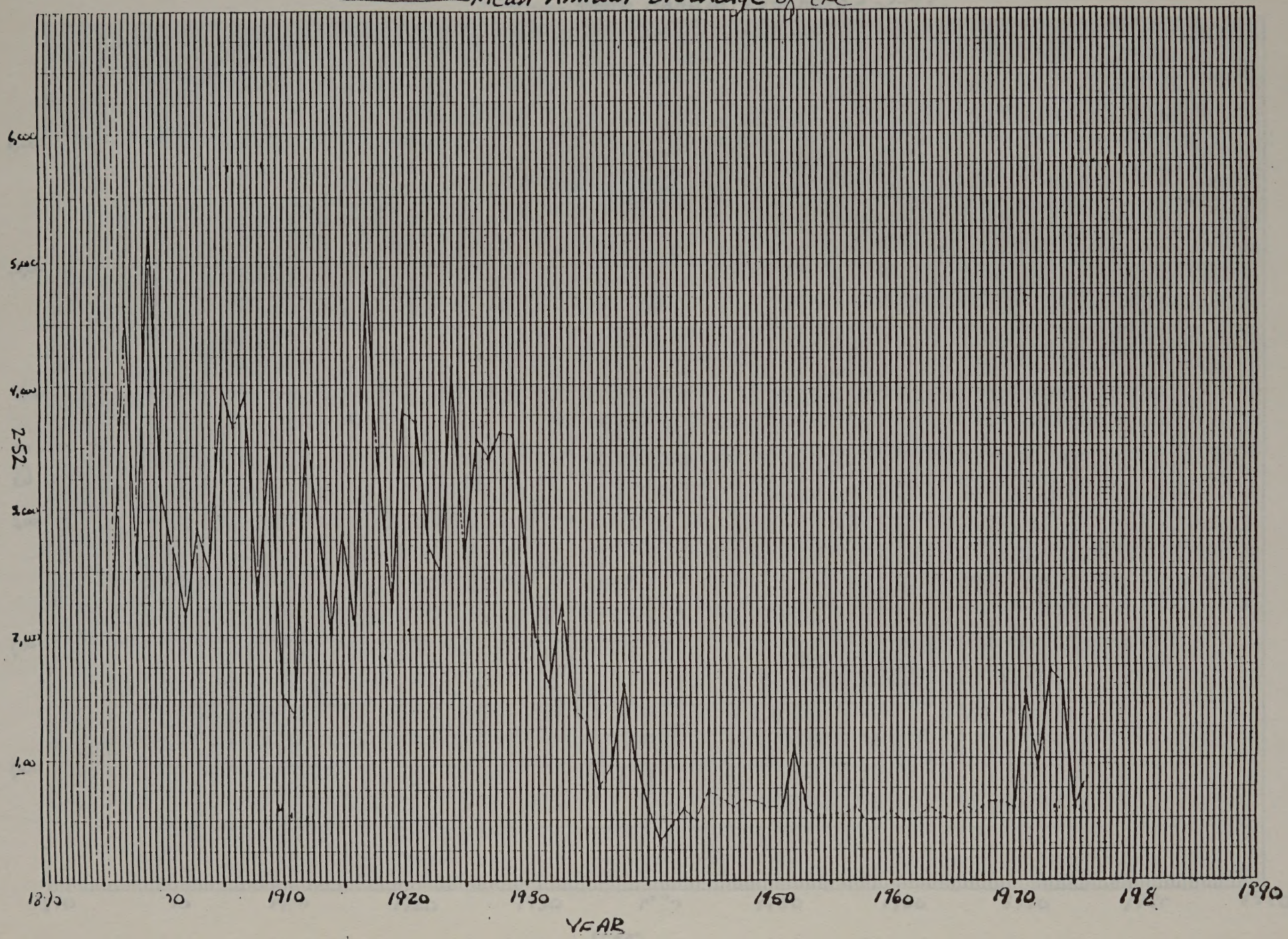
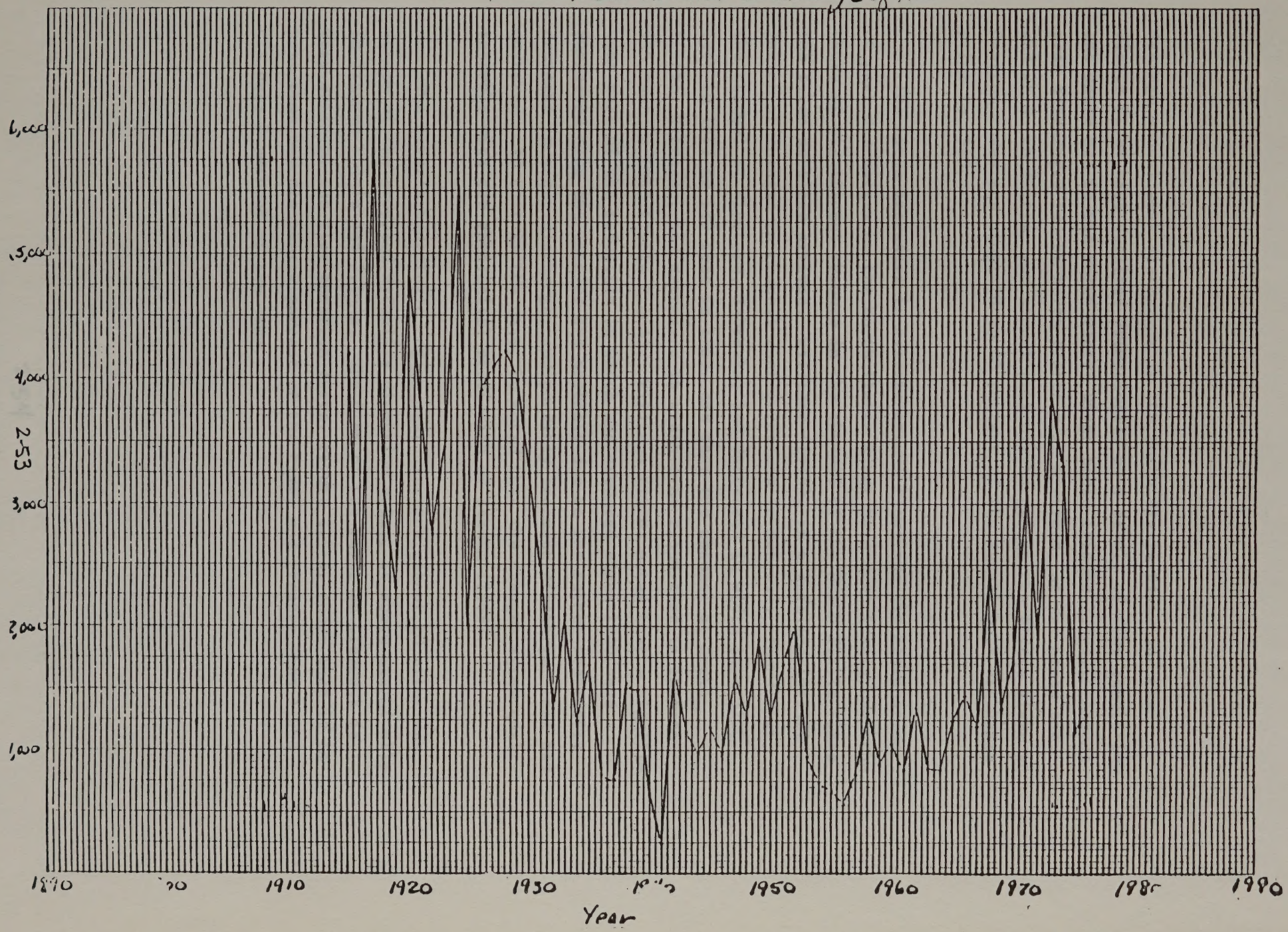


Figure 2.4-3d

Platte River near Overton
Mean Annual Discharge of the



Average annual peak discharges in the North Platte River and the Platte River have declined dramatically as a result of flow regulation and water use in the North Platte River basin (Figure 2.4-4). Annual peak discharges in the North Platte near Glenrock, at Tri-State Dam, and at North Platte, and annual peak discharges in the Platte River at Overton today are about 10 to 40 percent of the annual peak discharge prior to 1910.

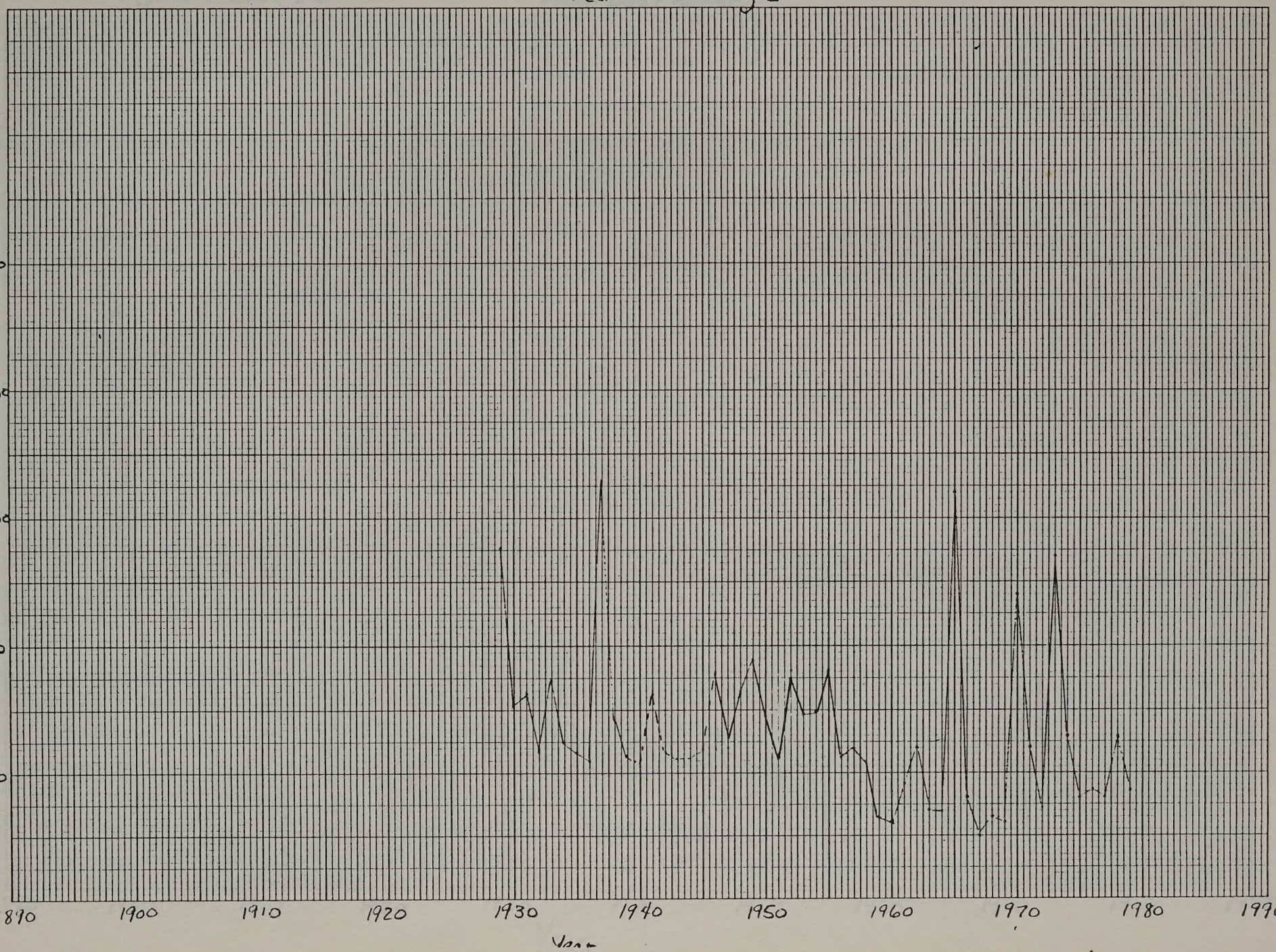
The large decreases in average annual flows and the attenuation of peak discharges on the North Platte River have most likely been the cause of significant changes in the channel of the North Platte since the first settlers arrived. Williams (1978), in a detailed investigation of changes in channel configurations in Nebraska, found that the channel at Minatare, Nebraska, had decreased in width from 3200 feet in 1865 to 180 feet in 1965, and that the channel at North Platte, Nebraska, had decreased in width from 2,590 feet in 1865 to 295 feet in 1965 (Table 2.4-4). Williams (1978) noted that a significant part of the reduction in width has occurred since 1940, and suggested that the changes are probably due to the rather systematic decrease in water discharge, and possibly sediment discharge, that has occurred. If this is the case, he noted that the changes agree qualitatively with the theoretical prediction of Schumm (1969).

The river's hydrologic regime near Glenrock, about 20 miles upstream of the proposed WyCoalGas diversion point, is shown graphically in Figures 2.4-3a and 2.4-4a. The flow of the river at Glenrock is very uniform; the flow duration curve, Figure 2.4-5, shows that it is less than 500 cfs only 2 percent of the time, and greater than 4,000 cfs only 2 percent of the time.

figure 2.4-4a

North Platte River near Glenrock

Peak Discharge



North Platte River at Bridgeport (1897-1928) and Wyo-Nebr State Line (1929-1978)

figure 2.4-4b

Peak Discharge

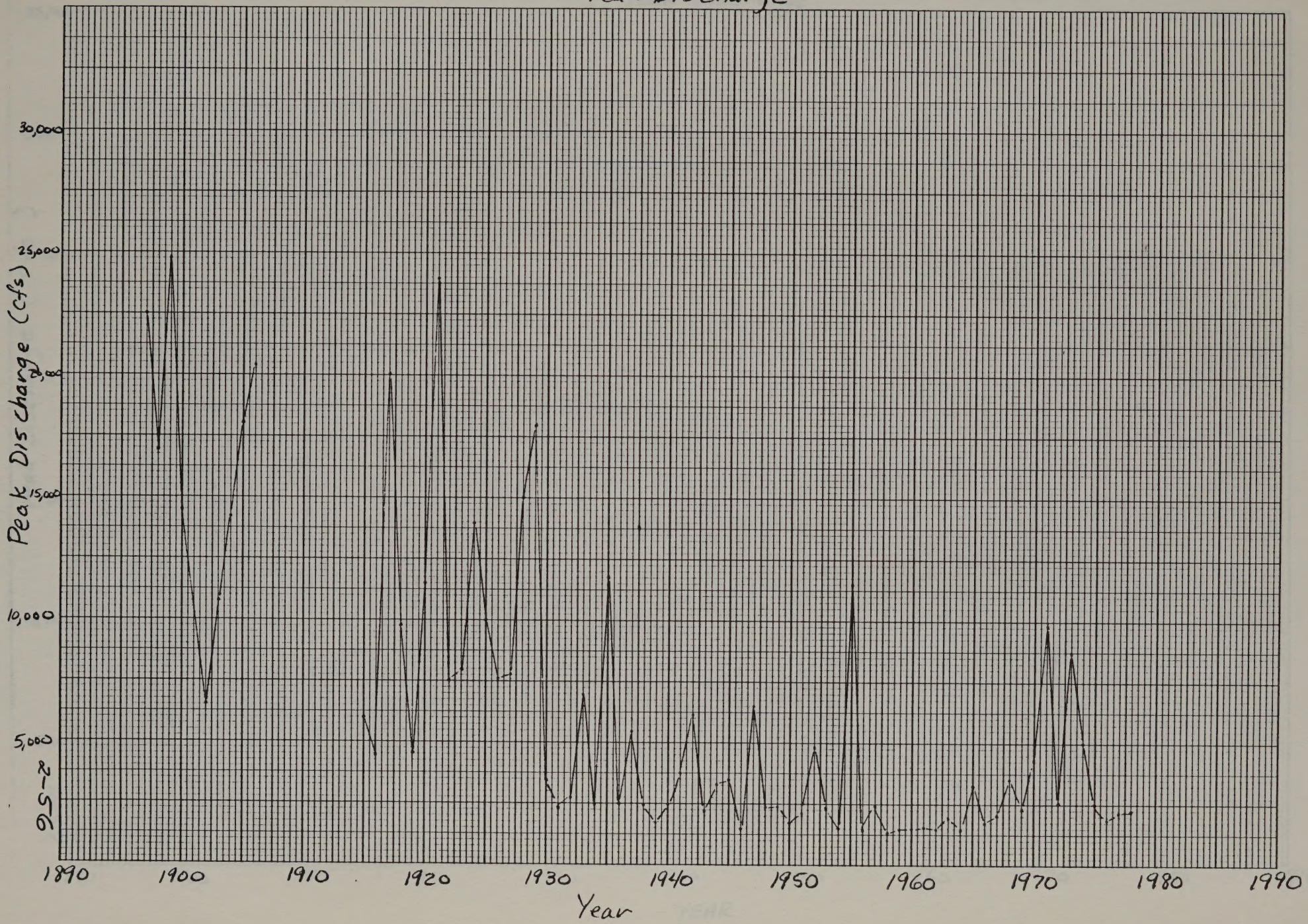


figure 2.4-4c

North Platte River at North Platte

Peak Discharge

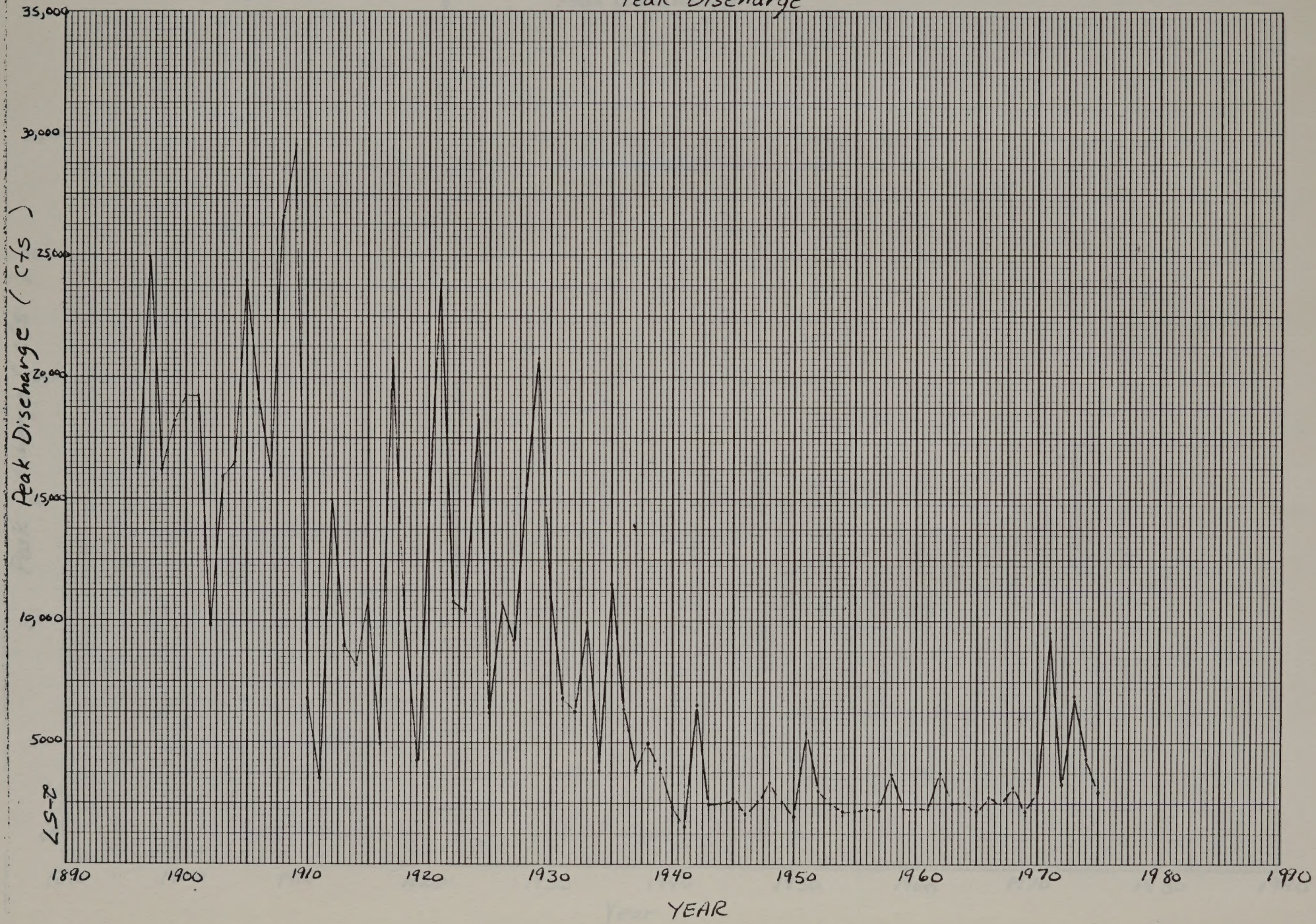


figure 2.4-4d

Platte River near Overton
Peak Discharge

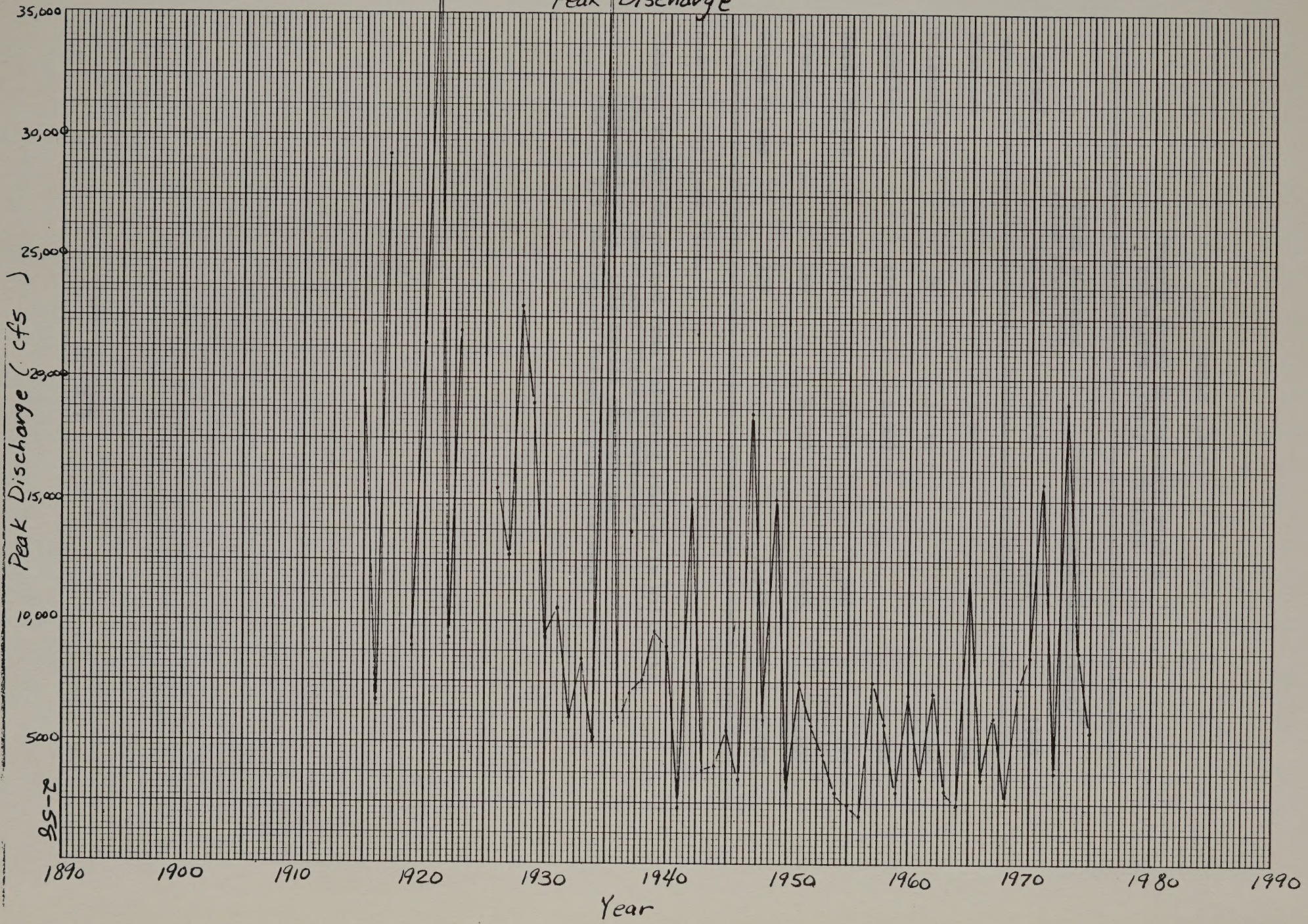


TABLE 2.4-4

CHANNEL WIDTH IN THE NORTH PLATTE AND PLATTE RIVERS, NEBRASKA

Location	River Distance Below State Line (miles)	Total Channel Width (feet)[a]		
		1865	1938	1965
Minatare	33	3,200		180
Bridgeport	56	3,740		400
Lewellen	114	2,900		490
North Platte	188	2,590	1,705	295
Overton	260	5,280	4,985	1,100
Grand Island	329		2,395	2,490

Source: Williams 1978.

[a]Channel widths determined from following sources in Williams:
1865 -- U.S. Government Plats of Nebraska
1938 -- U.S.D.A. 1938 aerial photographs
1965 -- U.S. Geological Survey topographic maps

TABLE 3.4-4

CHANNEL WIDTH IN THE NORTH PLATTE
AND PLATTE RIVERS, NEBRASKA

Location	River Distance Below State Line (miles)	Total Channel Width (feet)* 1861	1938	1963
Minatare	22	3,300		100
Bridgeport	34	3,740		400
Lewellen	124	2,800		490
North Platte	142	2,590	2,705	295
Overton	240	3,200	4,985	1,100
Grand Island	325		2,395	2,450

Source: Williams 1978.

*Channel width determined from aerial photo sources in Williams:
1861 — U.S. Government Plats of Nebraska
1938 — U.S.D.A. 1938 aerial photographs
1963 — U.S. Geological Survey topographic maps

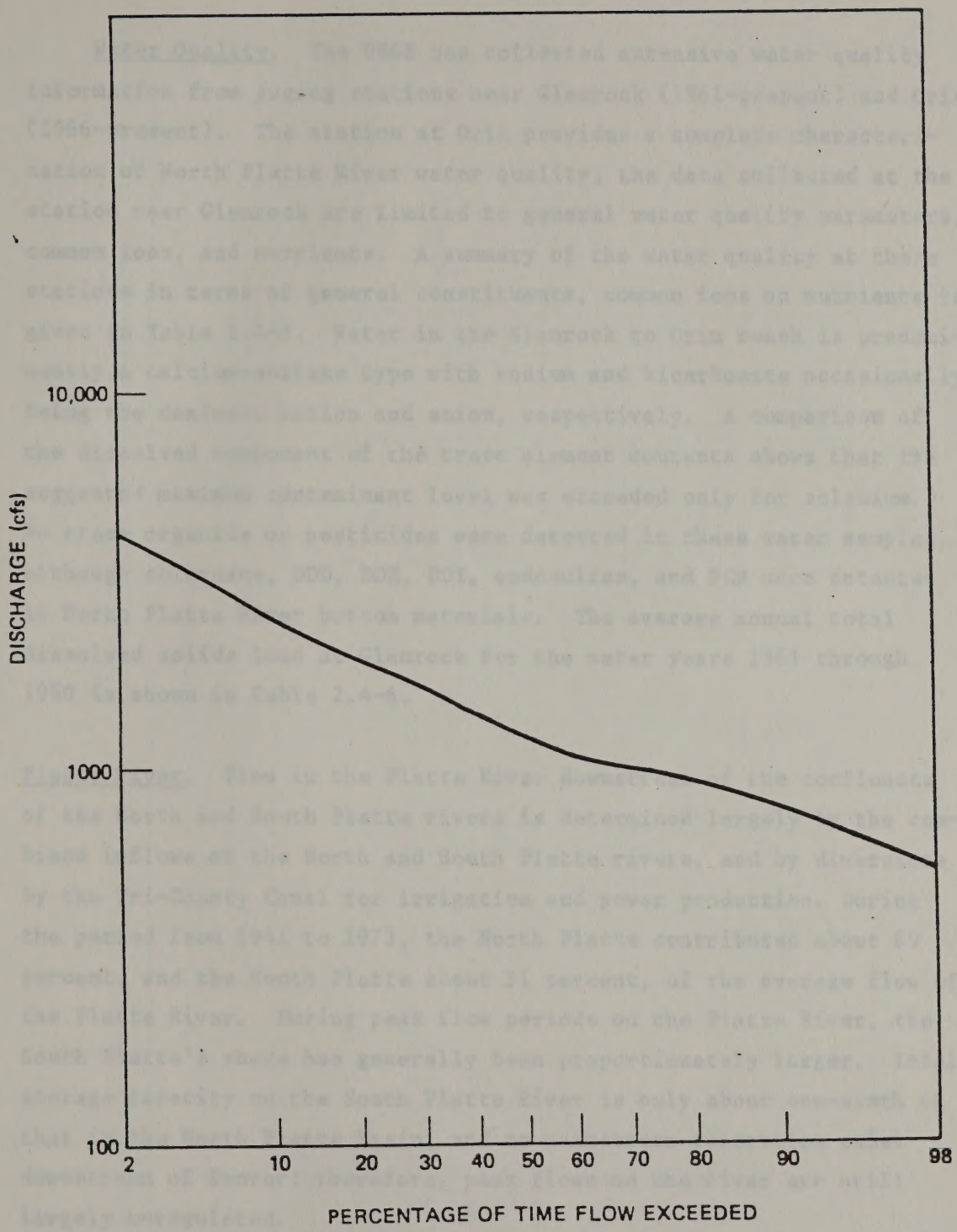


FIGURE 2.4-5
FLOW DURATION CURVE FOR NORTH PLATTE RIVER
NEAR GLENROCK (1961-1980)

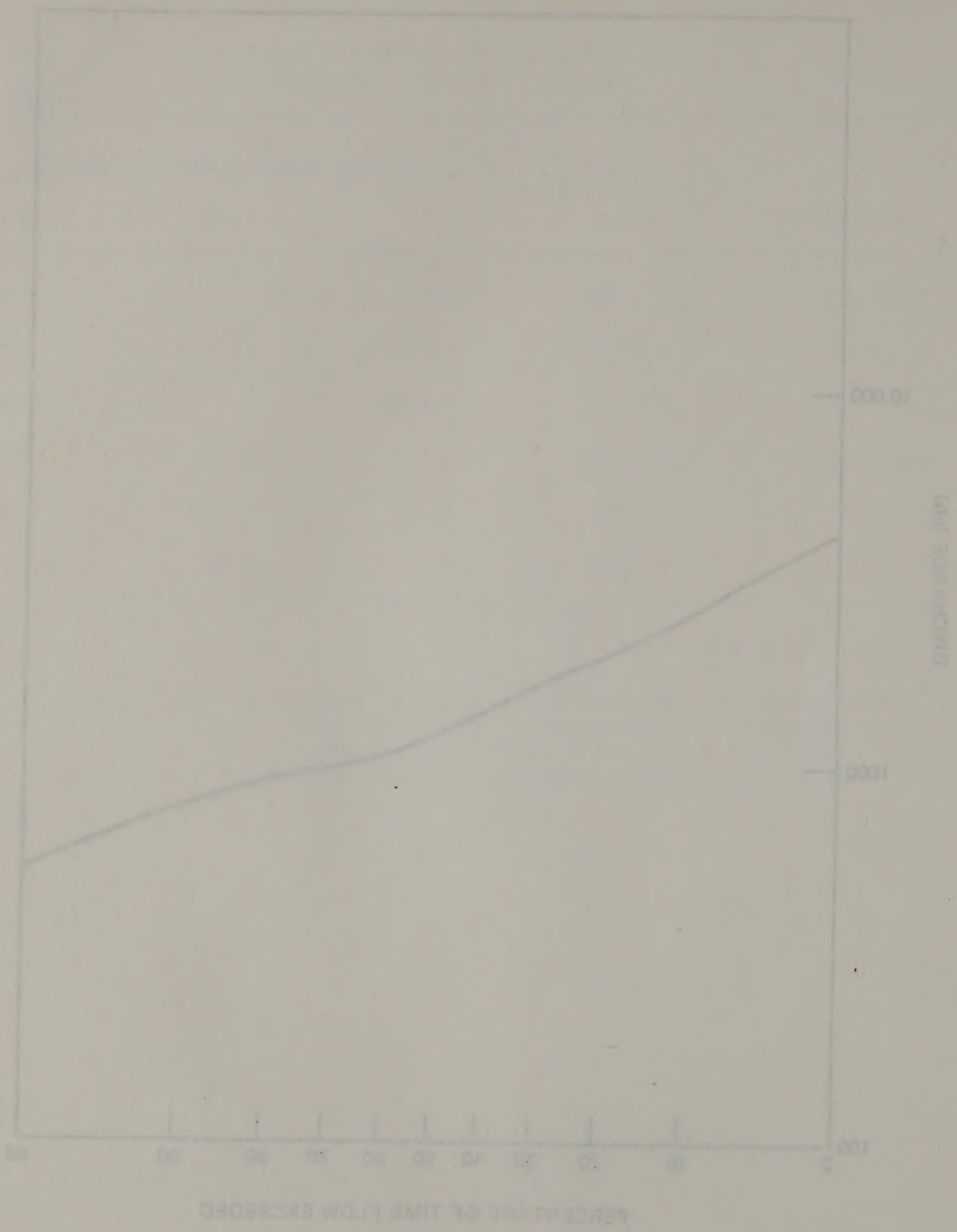


FIGURE 2.4A-5
FLOW DURATION CURVE FOR NORTH FLATTE RIVER
NEAR GLENROCK (1951-1959)

Water Quality. The USGS has collected extensive water quality information from gaging stations near Glenrock (1961-present) and Orin (1966-present). The station at Orin provides a complete characterization of North Platte River water quality; the data collected at the station near Glenrock are limited to general water quality parameters, common ions, and nutrients. A summary of the water quality at these stations in terms of general constituents, common ions on nutrients is given in Table 2.4-5. Water in the Glenrock to Orin reach is predominantly a calcium-sulfate type with sodium and bicarbonate occasionally being the dominant cation and anion, respectively. A comparison of the dissolved component of the trace element contents shows that the suggested maximum contaminant level was exceeded only for selenium. No trace organics or pesticides were detected in these water samples, although chlordane, DDD, DDE, DDT, endosulfan, and PCB were detected in North Platte River bottom materials. The average annual total dissolved solids load at Glenrock for the water years 1961 through 1980 is shown in Table 2.4-6.

Platte River. Flow in the Platte River downstream of the confluence of the North and South Platte rivers is determined largely by the combined inflows of the North and South Platte rivers, and by diversions by the Tri-County Canal for irrigation and power production. During the period from 1941 to 1973, the North Platte contributed about 69 percent, and the South Platte about 31 percent, of the average flow of the Platte River. During peak flow periods on the Platte River, the South Platte's share has generally been proportionately larger. Total storage capacity on the South Platte River is only about one-sixth of that in the North Platte Basin, and no mainstream reservoirs exist downstream of Denver; therefore, peak flows on the river are still largely unregulated.

Except at times of high flow, almost the entire flow of the Platte River is diverted by the Tri-County Supply Canal just below

TABLE 2.4-5

SUMMARY OF SELECTED WATER QUALITY CHARACTERISTICS OF THE NORTH PLATTE RIVER AT ORIN AND GLENROCK

Parameter [a]	Concentrations					
	Glenrock			Orin		
	Average	Minimum	Maximum	Average	Minimum	Maximum
General Constituents						
Flow, cfs	1,400	2.4	7,060	1,930	490	10,600
Water temperature, °C	12.5	0.0	27.5	11.2	0	26
pH, units	--	6.9	8.7	--	6.9	9.0
Conductivity, mhos/ m at 25°C	705	361	1,310	676	329	1,030
Total dissolved solids (sum)	453	236	963	520	410	710 (Residue at 105°C)
Suspended solids	78	11	144	845	6	62,500
Turbidity NTU				22	1	200
Total alkalinity, as $CaCO_3$	137	88	173	141	80	197
Total hardness, as $CaCO_3$	250	150	450	240	120	440
Dissolved oxygen	--	--	--	9.8	6.3	14.0
Common Ions						
Calcium	62	26	103	62	33	89
Magnesium	22	8	48	21	5.3	38
Sodium	55	20	150	53	17	110
Potassium	3.5	0.3	6.8	3.7	1.9	6.3
Iron (Dissolved)	0.06	0.0	0.2	0.06	0.0	0.49
Manganese (Dissolved)	--	--	--	0.007	0.0	0.02
Carbonate	0.3	0	10	1.0	0	12
Bicarbonate	166	107	211	171	98	240
Sulfate	203	83	479	192	61	338
Chloride	14.9	0.5	39	14	3.9	30
Fluoride	0.5	0.0	0.8	0.5	0.2	0.7
Boron	0.09	6.0	0.44	0.08	0.02	0.29
Nutrients						
Ammonia	1.3	0.8	1.5	0.02	0.0	0.05
Nitrate	1.9	0	14	1.9	0.0	18.2
Nitrite	5.9	1	9	--	--	--

Source: U.S. EPA 1981.

[a]All concentrations in mg/l unless otherwise indicated.

TABLE 2.4-6

AVERAGE ANNUAL TOTAL DISSOLVED SOLIDS
LOAD FOR THE NORTH PLATTE RIVER AT GLENROCK (1961-1980)

Water Year Oct-Sept	TDS Load (tons/month)	Yearly Load (tons)
1961	37,301	447,612
1962	43,550	522,600
1963	44,943	539,316
1964	54,610	655,320
1965	50,935	611,220
1966	51,470	617,640
1967	44,835	538,020
1968	50,431	605,172
1969	50,973	611,676
1970	43,213	518,556
1971	87,786	1,053,432
1972	47,274	566,556
1973	79,282	951,384
1974	83,738	1,006,056
1975	55,590	667,080
1976	51,826	621,912
1977	49,405	592,860
1978	56,687	680,244
1979	55,181	662,172
1980	59,234	710,808
Averages	54,927	659,124

Source: USGS, Wyoming State Office 1981.

TABLE 2.4-4

AVERAGE ANNUAL TOTAL DISCHARGED SOLIDS
LOAD FOR THE NORTH PLATTE RIVER AT GLENROCK (1961-1980)

Water Year Oct-Sept	TDS Load (tons/month)	Yearly Load (tons)
1961	37,381	447,612
1962	43,339	522,660
1963	44,963	539,316
1964	54,610	655,332
1965	36,855	411,230
1966	51,470	617,640
1967	44,829	538,020
1968	56,421	605,172
1969	50,975	611,676
1970	43,213	518,556
1971	87,765	1,053,432
1972	47,324	566,556
1973	79,293	951,384
1974	87,738	1,006,056
1975	55,760	667,080
1976	34,928	419,312
1977	49,403	592,840
1978	56,368	680,364
1979	55,191	662,172
1980	59,324	712,488
Average	54,937	659,244

Source: USGS, Wyoming District Office 1981.

the confluence of the North and South Platte rivers. The Platte's average flow above the diversion point was 1,860 cfs during the period from 1941 to 1973, and 544 cfs just below the diversion point (Figure 2.4-5a). Much of the water diverted to the Tri-County Supply Canal is returned to the river at the outlet of the Johnson hydroelectric plants, upstream of Overton and about 72 miles downstream of the diversion point. Return flows averaged 778 cfs, about 58 percent of the total flow, downstream at Overton, during the period 1941 to 1973. No significant diversions occur from the Platte River between Overton and Grand Island. Change in average annual flows and peak flows in the Platte River near Overton during the period 1885 to 1975 are shown in Figure 2.4-2d and 2.4-4d.

The Platte River, prior to settlement, was a very wide and shallow river with low herbaceous vegetation on the sandbars and banks of the river. Trees were wholly absent or consisted only of scattered cottonwoods and willows (Kellogg 1905). During the past century, the river channel has narrowed significantly, and dense forest growth has occurred on the islands and the banks. At many places, the river channel today is only one-tenth to one fifth as wide as it was in 1965 (Table 2.4-5a). The decrease in channel width has been caused by many factors, but the most important factor has been the decrease in flow caused by development in the Platte River system. Other important factors have been the planting of trees by the settlers which has provided a source of seeds, climatic change, bridge and road construction and agricultural activity (Endangered Species Committee 1979).

The decreases in channel width have been most dramatic in the reach of the Platte River between North Platte and Overton, which is the reach where flow reductions have also been the most dramatic. The present channel from North Platte to Overton averages between 200 and 600 feet wide, which represents about a 90% reduction from historical

Figure 2.4-5a Platte River Basin in South Central Nebraska

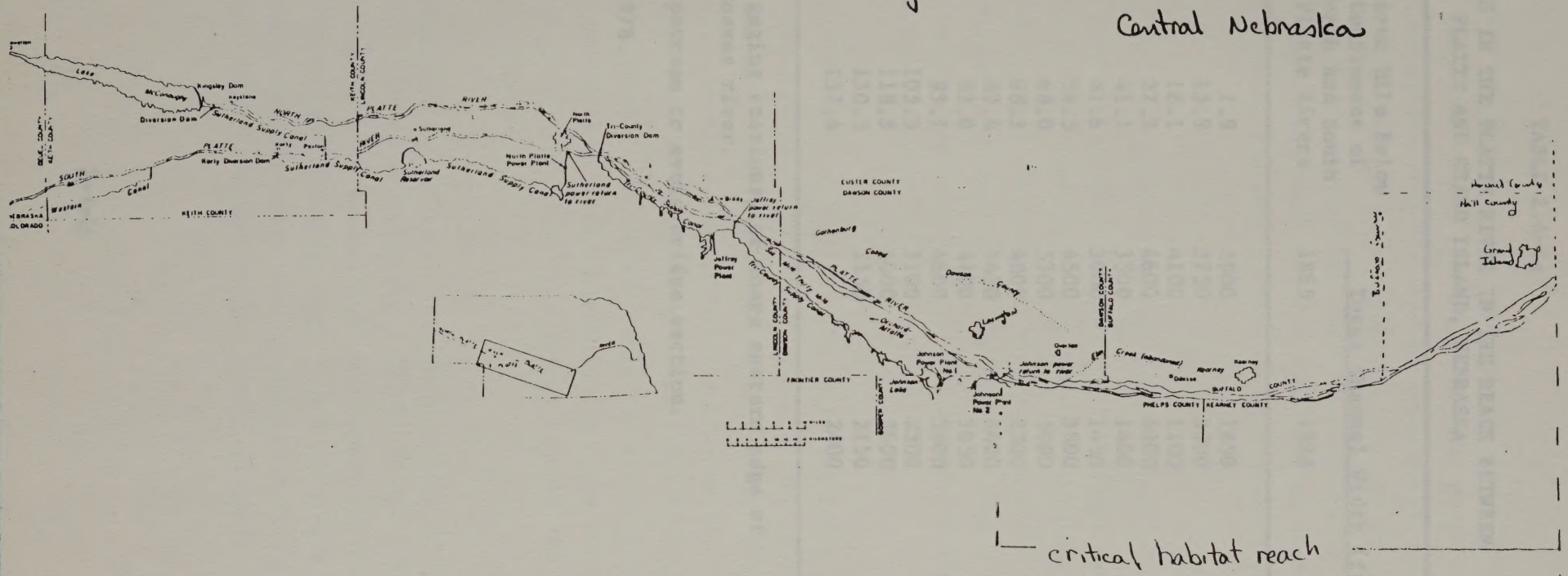


TABLE 2.4-5a

CHANNEL WIDTH IN THE PLATTE RIVER IN THE REACH BETWEEN NORTH PLATTE AND GRAND ISLAND, NEBRASKA

Location[a]	River Mile Below Confluence of North and South Platte Rivers	Total Channel Width (ft)[c] 1865	1938	1965
R. 30 W.	1.9	3900	1850	400
R. 28 W.	13.9	3750	3200	600
Brady	18.1	4100	1100	150
R. 26 W.	27.3	4600	4000	300
R. 24 W.	41.1	3500	1400	450
Cozad	41.6	3000	1450	130
R. 22 W.	54.5	4500	3800	200
Overton[b]	68.0	5300	5000	1100
Overton	68.3	4800	2900	1100
R. 18 W.	80.4	5450	4400	3700
Odessa	83.0	4100	3050	1600
R. 16 W.	93.1	4600	3900	3100
R. 14 W.	105.3	3100	2300	1600
R. 12 W.	118.3	4000	3600	2900
R. 10 W.[b]	130.5	2150	2150	1500
Grand Island	137.4		2400	2500

[a]Locations are USGS gaging stations, or where eastern edge of designated range crosses river.

[b]Located 0.3 miles upstream to avoid bridge section.

[c]Source: Williams 1978.

TABLE 2.4-5a

CHANNEL WIDTH IN THE PLATTE RIVER IN THE REACH BETWEEN NORTH PLATTE AND GRAND ISLAND, NEBRASKA

Location[a]	River Mile Below Confluence of North and South Platte Rivers	Total Channel Width (ft)[b] 1865	1938	1965
R. 30 W.	1.9	3900	1850	400
R. 28 W.	13.9	3750	3700	800
Brady	18.1	4100	1100	150
R. 26 W.	27.2	4800	4000	300
R. 24 W.	41.1	3500	1400	400
Cozad	41.5	3000	1450	130
R. 22 W.[b]	54.7	4500	3800	200
Overton	62.0	5300	3000	1100
Overton	68.7	4000	2000	1100
R. 18 W.	80.4	5450	4400	2700
Odessa	85.0	4100	3050	1800
R. 16 W.	93.1	4500	3700	3100
R. 14 W.	103.3	3100	2300	1600
R. 12 W.[b]	110.3	4000	3600	2000
R. 10 W.	120.5	2100	2150	1300
Grand Island	127.4		2400	2900

[a]Locations are USGS gaging stations, or where stations also of designated range crosses river.

[b]Located 0.3 miles upstream to avoid bridge sections.

[c]Source: Williams 1978.

widths. Between Overton and Grand Island, the channel now averages about 1,500 to 3,000 feet wide, about two-thirds as wide as at the turn of the century (FWS 1978). The Fish and Wildlife Service (1978) reported that vegetation growth has been particularly heavy in the reach above Overton, and that encroachment has been significant in some reaches between Overton and Grand Island, and minor in others. River flows are similar along the entire reach between Overton and Grand Island.

Sandhill cranes, and presumably whooping cranes, formerly utilized most of the Platte River in south-central Nebraska. Today, cranes distribution is largely restricted to a 70-mile reach between Overton and Grand Island, wth high densities of cranes found only in the Kearny to Grand Island reach and in the Elm Creek to Odessa reach (Krapu 1981). Crane use is highly correlated with channel widths of greater than 500 feet (Krapu 1981).

LaPrele Creek. LaPrele Creek is a small tributary of the North Platte River that drains an area of 177 square miles on the northeastern slope of the Laramie Mountains southwest of Douglas (Figure 2.4-6). The creek has a natural average flow of approximately 26,000 acre-feet per year. Its flow is regulated by LaPrele Reservoir, with a capacity of 20,000 acre-feet, and several small reservoirs with a combined capacity of approximately 140 acre-feet. Upstream diversions from Rocky Ford, Gould, Reed, and Wagonhound creeks augment the natural flow in LaPrele Creek.

Water Use and Water Rights. Waters from LaPrele Creek are used to irrigate about 17,525 acres, of which about 10,305 acres belong to the Douglas Reservoir Water Users Association, the owners of the LaPrele Dam and Reservoir. Additionally, about 4,600 acres are irrigated with direct flow diversions above LaPrele Reservoir, and about 1,470 acres with direct flow diversions below LaPrele Reservoir. In

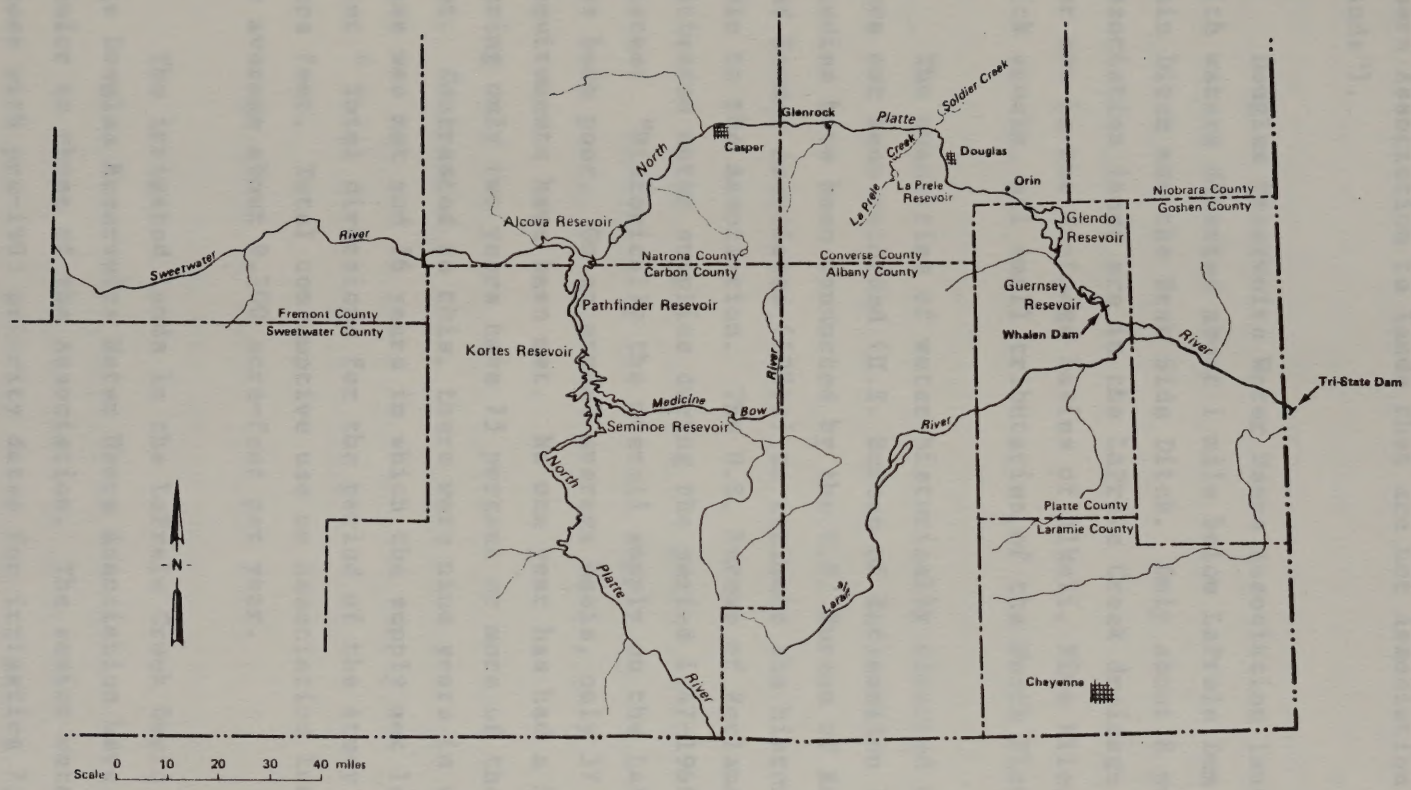


Figure 2.4-6 Location of LaPrele Creek Drainage Basin
(to be replaced with map of LaPrele Creek basin)

addition, about 1,150 acres are irrigated with waters conveyed under contract by the distribution system of the Douglas Reservoir Water Users Association to lands that are not Association lands ("carrier lands").

Douglas Reservoirs Water Users Association lands are irrigated with waters diverted about 1 mile below LaPrele Dam into the LaPrele Main Ditch and the West Side Ditch. Only about 8 percent of the Association lands are in the LaPrele Creek drainage basin; the remainder are in the drainage basins of Alkali, Five Mile, Six Mile, and Bed Tick creeks, all small tributaries of the North Platte River.

The quantities of water historically diverted by the Association have not been recorded (U.S. Bureau of Reclamation 1969b). Operation studies have been conducted by the U.S. Bureau of Reclamation (1969b) and Banner Associates (1981a) to estimate the historic supply available to the Association. The U.S. Bureau of Reclamation (1969b) estimated water supplies during the period 1947-1966. Their report states: "Historically the overall supply on the LaPrele Project has been poor. On an annual average basis, only 37 percent of the requirements have been met. No one year has had a full supply, and during only two years have 75 percent or more of the requirements been met. Contrasted to this, there were nine years in which 30 percent or less was met and 16 years in which the supply met less than 60 percent." Total diversions for the period of the study averaged 17,900 acre feet. Total consumptive use on Association lands was estimated to average about 9,300 acre-feet per year.

The irrigated lands in the LaPrele Creek basin that are not in the Douglas Reservoirs Water Users Association have water rights senior to those of the Association. The senior water rights include those with pre-1905 priority dates for irrigating 7,683 acres upstream

of LaPrele Reservoir, those with 1878-1908 priority dates for irrigating 1,276 acres downstream of LaPrele Reservoir, and those with 1884-1907 priority dates for irrigating 1,033 acres of carrier lands. The Association has storage rights with priority dates of 1905 and 1909 for storage of 20,000 acre-feet of water, and direct diversion rights for irrigating 11,255 acres with a 1909 priority date. The Association also has direct flow rights of 5.50 cfs with a 1931 priority date for transbasin diversion from Reed, Gould, and Wagonhound creeks via the Downey Park System.

The original storage permits for LaPrele Reservoir were amended at the request of the Douglas Reservoirs Water Users Association by Board of Control Order No. 20, May 19, 1975. The major stipulations in Board of Control Order No. 20 were:

- No water right on LaPrele Creek shall be injured.
- The original permit for LaPrele Reservoir shall be amended to permit industrial use upon completion of LaPrele Dam rehabilitation by Panhandle Eastern.
- Panhandle Eastern is authorized to divert up to 5,000 acre-feet per year, to be conveyed from LaPrele Reservoir down LaPrele Creek to the North Platte River and down the North Platte River to Panhandle Eastern's diversion point.
- Panhandle Eastern releases shall be limited to 2,500 acre-feet during the period October 1 through April 30.
- In event of shortages during the period May 1 through September 30, water shall be apportioned 25 percent to Panhandle Eastern and 75 percent to the Association.

of Lafrenia Reservoir, those with 1879-1903 priority dates for irrigating 1,715 acres downstream of Lafrenia Reservoir, and those with 1884-1907 priority dates for irrigating 1,021 acres of pasture lands. The Association has storage rights with priority dates of 1905 and 1907 for storage of 20,000 acre-feet of water, and direct diversion rights for irrigating 11,775 acres with a 1907 priority date. The Association also has direct flow rights of 3.50 cfs with a 1931 priority date for transbasin diversions from Ward, Gould, and Waycobonne creeks via the Downey Park System.

The original storage permits for Lafrenia Reservoir were granted at the request of the Douglas Reservoirs Water Users Association by Board of Control Order No. 20, May 19, 1915. The major stipulations in Board of Control Order No. 20 were:

* No water rights on Lafrenia Creek shall be injured.

* The original permit for Lafrenia Reservoir shall be amended to permit industrial use upon completion of Lafrenia Dam rehabilitation by Pendrella Waters.

* Pendrella Waters is authorized to divert up to 3,000 acre-feet per year, to be conveyed from Lafrenia Reservoir down Lafrenia Creek to the Rocky Plateau River and down the North Plateau River to Pendrella Waters's diversion point.

* Pendrella Waters releases shall be limited to 2,500 acre-feet during the period December 1 through April 30.

* In event of shortages during the period May 1 through September 30, water shall be apportioned 25 percent to Pendrella Waters and 75 percent to the Association.

- All dam leakage shall be charged to Panhandle Eastern.

- All water delivered to Panhandle Eastern by the Association shall be subtracted from the annual entitlement of water for LaPrele Reservoir.

Hydrology. The average annual flows of LaPrele Creek at the gaging stations above the reservoir and near the mouth are shown in Figure 2.4-7. Average annual flows during the period 1929 to 1970, when flows at each station were recorded, were 25,140 and 8,020 acre-feet per year at the upstream and downstream stations, respectively. Extrapolation of studies conducted by the U.S. Bureau of Reclamation (1969b) suggests that the additional annual flow from that part of the drainage basin between the upstream and downstream gages is about 10 percent of the annual flow at the upstream station. Average annual surface water consumption by reservoir evaporation, irrigation, and out of basin diversion via the West Side and LaPrele ditches is therefore estimated to be about 19,630 acre-feet per year. About 40 percent of the water diverted out of the basin for irrigation via the West Side and LaPrele ditches to Alkali Creek, Five Mile Creek, Six Mile Creek, and Bed Tick Creek drainage basins returns to the North Platte River (U.S. Bureau of Reclamation 1969b). Maximum flows in LaPrele Creek generally occur during spring snowmelt in April and May.

Flow duration curves for La Prele Creek above the reservoir and near the mouth are shown in Figure 2.4-8. A flow of less than 0.1 cfs occurred at the gaging station near the mouth about 7 percent of the time, and a flow of greater than 0.5 cfs occurred at the upstream station more than 98 percent of the time. The 7-day 5-year low flow near the mouth is 0.0 cfs.

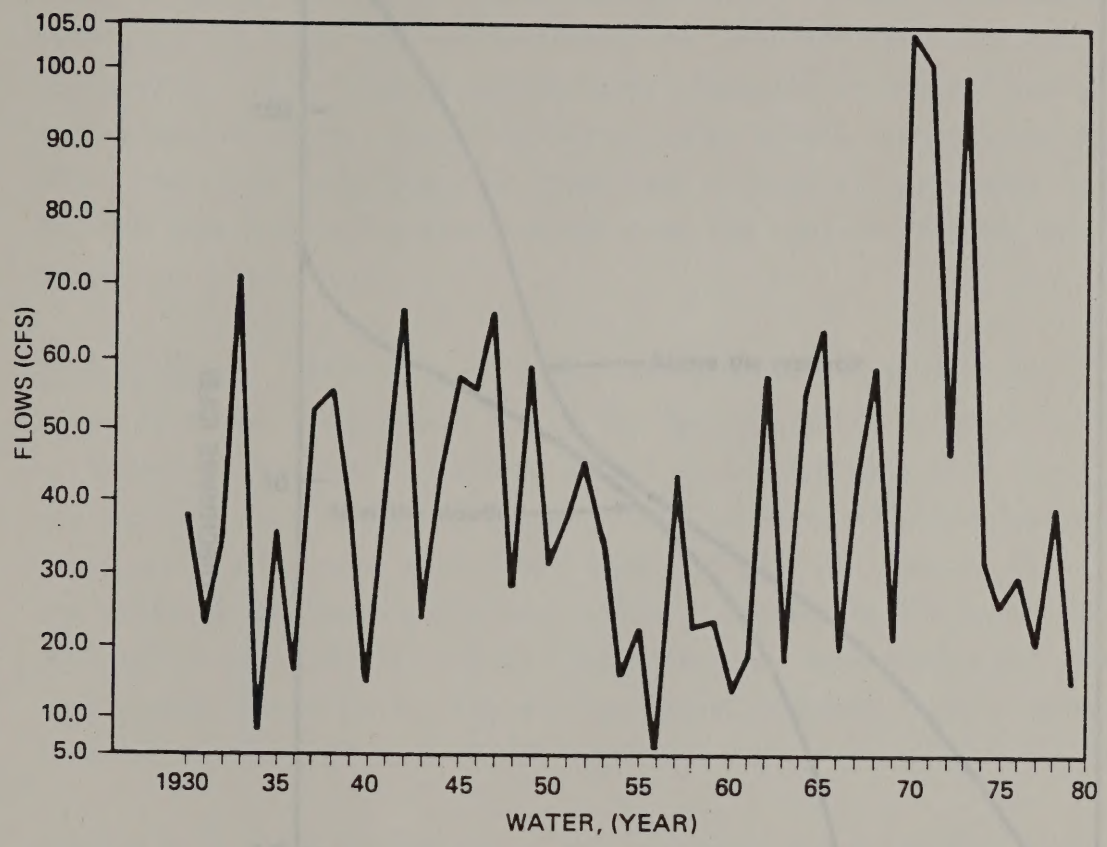


Figure 2,4-7
AVERAGE ANNUAL FLOWS IN LA PRELE CREEK 1930-1979

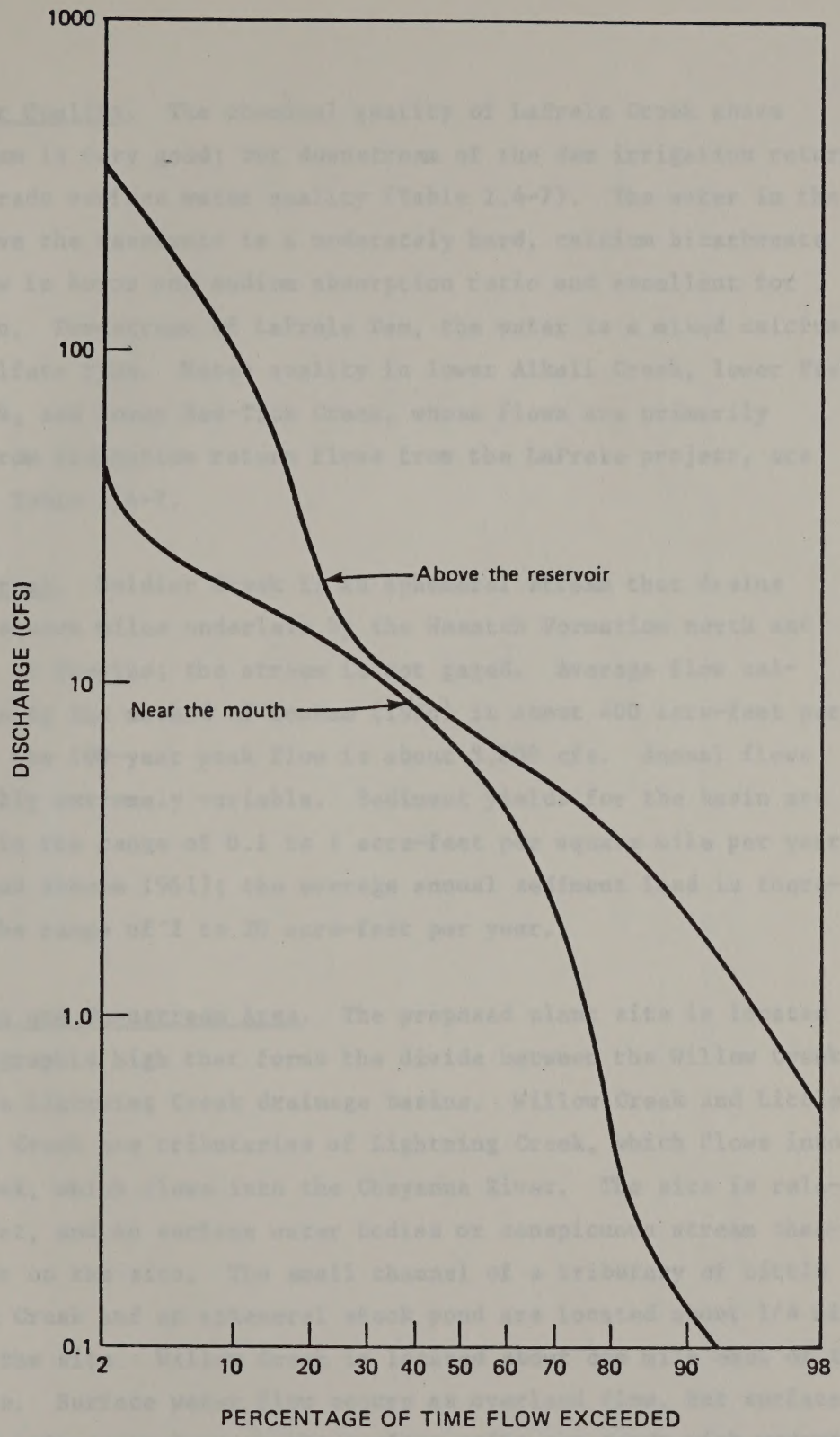


Figure 2.4-8
FLOW DURATION CURVE FOR LA PRELE CREEK NEAR DOUGLAS (ABOVE THE RESERVOIR) AND ORPHA (NEAR THE MOUTH) . (BASED ON 1936-1971 PERIOD OF RECORD)

2-73/74

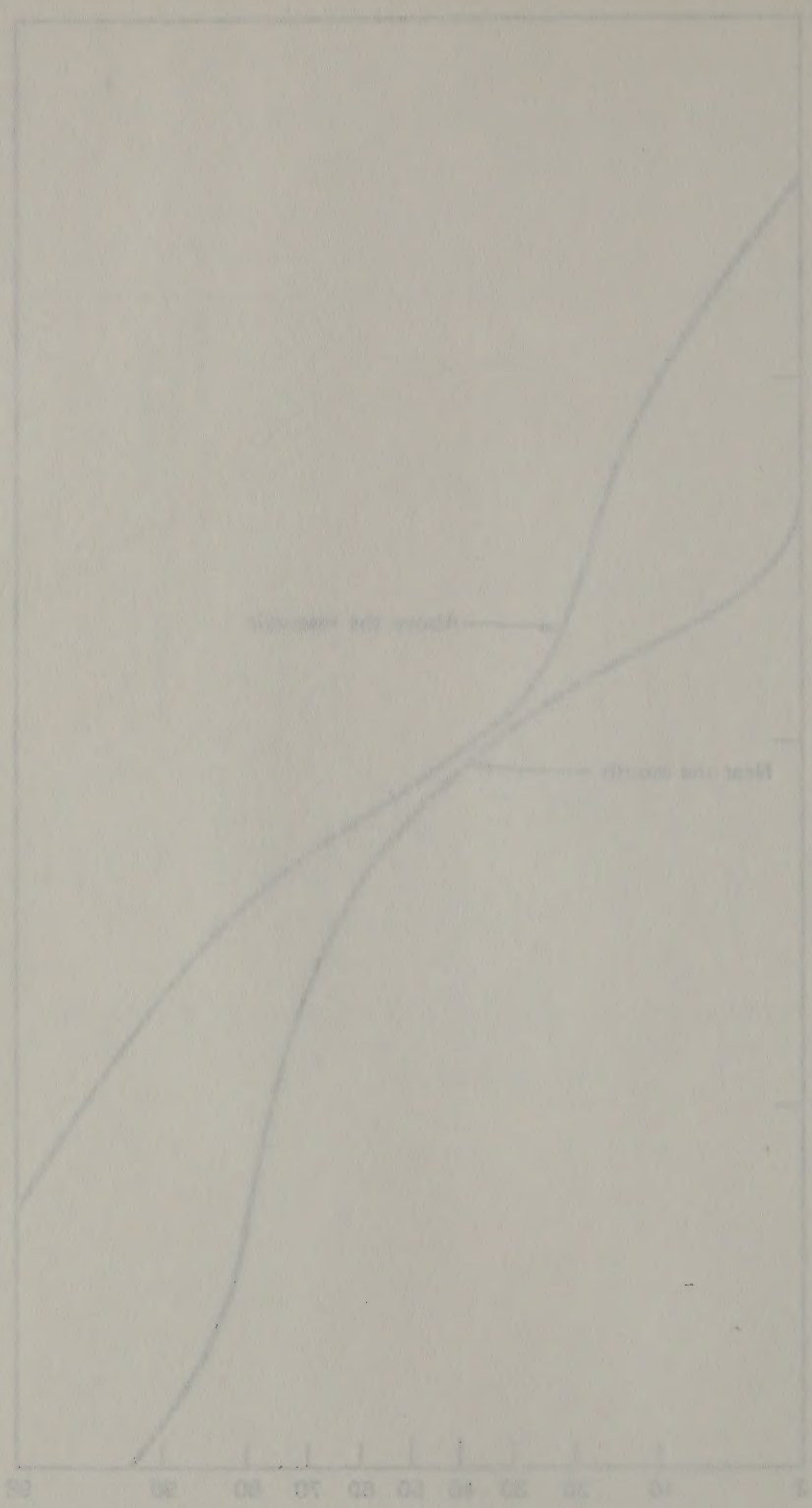


Figure 2.4-8
FLOW DURATION CURVE FOR LA PINELE CREEK NEAR DOUGLAS
(ABOVE THE RESERVOIR) AND ORFILA (NEAR THE MOUTH)
(BASED ON 1930-1971 PERIOD OF RECORD)

Water Quality. The chemical quality of LaPrele Creek above LaPrele Dam is very good; but downstream of the dam irrigation return flows degrade surface water quality (Table 2.4-7). The water in the creek above the reservoir is a moderately hard, calcium bicarbonate water, low in boron and sodium absorption ratio and excellent for irrigation. Downstream of LaPrele Dam, the water is a mixed calcium sodium sulfate type. Water quality in lower Alkali Creek, lower Five Mile Creek, and lower Bed-Tick Creek, whose flows are primarily derived from irrigation return flows from the LaPrele project, are listed in Table 2.4-7.

Soldier Creek. Soldier Creek is an ephemeral stream that drains about 29 square miles underlain by the Wasatch Formation north and northwest of Douglas; the stream is not gaged. Average flow calculated using the method of Lowham (1976) is about 400 acre-feet per year, and the 100-year peak flow is about 5,000 cfs. Annual flows are probably extremely variable. Sediment yields for the basin are probably in the range of 0.1 to 1 acre-feet per square mile per year (Hadley and Schumm 1961); the average annual sediment load is therefore in the range of 2 to 20 acre-feet per year.

Plant Site and Downstream Area. The proposed plant site is located on a topographic high that forms the divide between the Willow Creek and Little Lightning Creek drainage basins. Willow Creek and Little Lightning Creek are tributaries of Lightning Creek, which flows into Lance Creek, which flows into the Cheyenne River. The site is relatively flat, and no surface water bodies or conspicuous stream channels occur on the site. The small channel of a tributary of Little Lightning Creek and an ephemeral stock pond are located about 1/4 mile south of the site. Willow Creek is located about one mile east of the plant site. Surface water flow occurs as overland flow, but surface flows are infrequent because the surface soils are sandy with moderate

Water Quality. The chemical quality of Lafrenia Creek above Lafrenia Dam is very good; but downstream of the dam irrigation return flows degrade surface water quality (Table 2.4-7). The water in the creek above the reservoir is a moderately hard, calcium bicarbonate water, low in boron and sodium absorption ratio and acceptable for irrigation. Downstream of Lafrenia Dam, the water is a mixed cation sodium sulfate type. Water quality in lower Alkali Creek, lower Five Mile Creek, and lower Bad-Luck Creek, whose flows are primarily derived from irrigation return flows from the Lafrenia project, are listed in Table 2.4-7.

Soldier Creek. Soldier Creek is an ephemeral stream that drains about 29 square miles underlain by the Wasatch formation north and northwest of Douglas; the stream is not gaged. Average flow calculated using the method of Lowham (1976) is about 600 acre-feet per year, and the 100-year peak flow is about 3,000 cfs. Annual flows are probably extremely variable. Sediment yields for the basin are probably in the range of 0.1 to 1 acre-foot per square mile per year (Dalley and Schumm 1961); the average annual sediment load is therefore in the range of 3 to 30 acre-feet per year.

Plant Site and Downstream Area. The proposed plant site is located on a topographic high that forms the divide between the Willow Creek and Little Lightning Creek drainage basins. Willow Creek and Little Lightning Creek are tributaries of Lightning Creek, which flows into Lance Creek, which flows into the Cheyenne River. The site is relatively flat, and no surface water facilities or complicated stream channels occur on the site. The small channel of a tributary of Little Lightning Creek and an ephemeral stock pond are located about 1/4 mile south of the site. Willow Creek is located about one mile east of the plant site. Surface water flow occurs as overland flow, but surface flows are infrequent because the surface soils are sandy with moderate

TABLE 2.4-7

WATER QUALITY OF LAPRELE CREEK AND STREAMS
DRAINING DOUGLAS RESERVOIR WATER USERS ASSOCIATION LANDS[a]

Constituents	Upper LaPrele Creek at Gage	Lower LaPrele Creek at Gage	Lower Alkali Creek	Lower Five Mile Creek	Lower Bed-Tick Creek
Na	14	111	478	348	122
Ca	39	36	32	19	55
Mg	7	6	9	6	16
K	5	12	24	23	12
HCO_3	177	289	407	563	165
SO_4	38	155	866	363	343
Cl	4	11	24	35	16
TDS	194	480	1,633	1,071	644

[a]Average concentration of seven samples taken at each location during the period November 1966 to May 1967 by U.S. Bureau of Reclamation (1969c).

TABLE 2.4-7

WATER QUALITY OF LAFRENIE CREEK AND STREAMS
SERVICING TROUBLE RESERVOIR WATER USERS ASSOCIATION LANDS[a]

Constituents	Upper Lafrenie Creek at Gage	Lower Lafrenie Creek at Gage	Lower Abbott Creek	Lower Five Mile Creek	Lower Red-Fish Creek
Na	14	111	478	348	117
Ca	35	36	32	19	55
Mg	7	6	9	6	16
K	5	17	14	23	12
SO_4	171	494	487	543	145
SO_4	18	533	546	367	343
Cl	4	11	24	35	16
TDS	194	240	1,633	1,071	444

[a]Average concentration of seven samples taken at each location during the period December 1964 to May 1967 by U.S. Bureau of Reclamation (1969).

infiltration rates. Annual average sediment yield from the plant site is likely in the range of 0.05 to 0.25 acre-feet per square mile (Hadley and Schumm 1961).

Previous water quality monitoring efforts in the vicinity of the plant site have involved chemical analyses of samples from a small pond about 1/4 mile southwest of the facilities area and from tributaries of Lightning Creek. The chemical quality of the pond water in September 1973 is provided in Table 2.4-8. This water is a sodium-sulfate type, low in total dissolved solids, and suitable for irrigation and stock watering. The very high quality probably indicates that little or no ground-water inflow into the pond was occurring, and that the water was collected soon after a summer thunder shower before significant concentration by evaporation occurred.

Chemical analyses of the water found in a tributary of Little Lightning Creek and in Willow Creek in 1975 near the site are listed in Table 2.4-9. These waters are very low in total dissolved solids and appear to be suitable for most uses, including irrigation, stock watering, and domestic consumption. The very low total dissolved solids content probably indicates little or no ground-water contribution to these runoff waters. The concentrations of selected elements in sediment collected from the tributary of Little Lightning Creek during April 1975 and from a composite of soil samples taken from the plant site are presented in Table 2.4-10.

Stream Crossings By Linear Facilities. The proposed product pipeline, water pipelines, and railroad would cross two major rivers (the North Platte and the Laramie) and six minor perennial streams, as well as numerous ephemeral and intermittent courses. Stream classifications and selected water quality statistics for the major rivers and streams to be crossed are listed in Table 2.4-11.

TABLE 2.4-8

WATER QUALITY IN POND SOUTHWEST OF THE FACILITIES AREA[a]

Water Quality Parameters[b]	Concentration
General Constituents	
Water temperature (°C)	13.5
pH, units	9.8
Total dissolved solids, calculated	183
Turbidity (JTU)	20
Total alkalinity (as $CaCO_3$)	30
Total hardness (as $CaCO_3$)	70
Dissolved oxygen	10.1
Common Ions	
Calcium[c]	17
Magnesium[c]	7
Potassium[c]	6
Sodium[c]	30
Iron	0.5
Manganese	0.017
Carbonate[d]	7.3
Bicarbonate	22
Sulfate	100
Chloride	2.5
Nitrate (as N)	0.45
Fluoride	0.33
Trace Elements	
Arsenic	0.008
Barium	0.007
Cadmium	<0.005
Chromium	0.003
Copper	0.05
Lead	0.08
Mercury	<0.001
Selenium	<0.01
Silver	<0.006
Zinc	0.013

[a]This water sample was collected during September 1973 from a small pond located 1/4 mile southwest of the facilities area, in the NW1/4SW1/4 sec. 33, T. 35 N., R 70 W., on a first-order tributary of Little Lightning Creek. Approximate surface area was 1.0 acre.
[b]All concentrations in mg/l unless otherwise indicated.
[c]Estimated from knowledge of total hardness, total meq/l of anions and Ca/Mg and Na/K ratios.
[d]Estimated from total meq/l for both bicarbonate and carbonate.

Source: Metronics 1975

TABLE 2.4-9

WATER QUALITY IN POND SOUTHWEST OF THE FACILITIES AREA[a]

Water Quality Parameters[b]	Concentration
General Constituents	
Water temperature (°C)	13.3
pH, units	8.8
Total dissolved solids, calculated	180
Turbidity (JTU)	30
Total alkalinity (as $CaCO_3$)	39
Total hardness (as $CaCO_3$)	70
Dissolved oxygen	10.1
Common Ions	
Calcium	17
Magnesium[c]	7
Potassium	5
Sodium	30
Iron	0.5
Manganese	0.027
Carbonate[d]	7.3
Bicarbonate	27
Sulfate	100
Chloride	2.3
Nitrate (as N)	0.45
Fluoride	0.31
Trace Elements	
Arsenic	0.009
Barium	0.007
Cadmium	<0.003
Chromium	0.003
Copper	0.03
Lead	0.02
Mercury	<0.001
Selenium	<0.01
Silver	<0.006
Zinc	0.013

[a]This water sample was taken from a shallow depression in/23 from a small pond located 1/4 mile southwest of the facilities area, in the NW1/4SW1/4 sec. 33, T. 33 N., R 70 W., on a Sixth-order tributary of Little Lightning Creek. Approximate surface area was 1.0 acre.

[b]All concentrations in mg/l unless otherwise indicated.

[c]Estimated from knowledge of total hardness, total mg/l of anions and Ca/Mg and Na/K ratios.

[d]Estimated from total mg/l for both bicarbonate and carbonate.

Source: Morrison 1975

TABLE 2.4-9

WATER QUALITY IN STREAMS NEAR THE PLANT SITE

Parameter	Concentrations[a]		
	Site 1 Tributary of Little Lightning Creek		Site 2 Willow Creek
	4/25/75[b]	6/20/75	6/20/75[c]
Conductivity (μmhos/cm)	-	81	91
Total dissolved solids	44	74	88
Calcium	5	6	3
Magnesium	3	2	2
Sodium	2	11	20
Potassium	8	10	8
Iron	-	0.38	3.3
Manganese	-	0.002	0.019
Carbonate	0	0	0
Bicarbonate	34	44	37
Sulfate	7	21	35
Chloride	2	2	2
Silicon	-	3.4	>10
Phosphorus	-	0.27	0.058
Aluminum		0.37	2.0
Arsenic		0.005	0.002
Barium		0.015	0.052
Bromine		0.016	0.007
Cadmium		-	0.001
Chromium		0.001	0.027
Cobalt		-	0.001
Copper		0.051	0.033
Lead		0.001	0.006
Molybdenum		0.001	0.002
Nickel		0.003	0.010
Selenium		<0.001	<0.001
Silver		-	0.014
Strontium		0.025	0.038
Vanadium		0.005	0.012
Zinc		0.55	0.73

Source: Metronics 1975.
[a]Concentrations are mg/l unless otherwise indicated.
[b]Water collected during snowmelt by an inplace sampling jar.
[c]Water collected after a rain event by an inplace sampling jar.

TABLE 2.4-4

WATER QUALITY IN STREAMS NEAR THE PLANT SITE

Parameter	Concentration[a]		
	Site 1		Site 2
	Tributary of Little Lightning Creek		Willow Creek
	4/23/75[b]	6/20/75	4/30/75[c]
Conductivity (µmhos/cm)	—	81	91
Total dissolved solids	44	74	88
Calcium	5	8	3
Magnesium	3	4	2
Sodium	5	11	20
Potassium	3	10	8
Iron	1	0.28	1.3
Manganese	—	0.002	0.019
Carbonate	0	0	0
Bicarbonate	34	44	32
Sulfate	7	21	35
Chloride	2	2	8
Silica	—	3.4	210
Phosphorus	—	0.27	0.029
Aluminum		0.37	2.0
Arsenic		0.001	0.001
Barium		0.013	0.053
Bromine		0.016	0.027
Cadmium		—	0.001
Chromium		0.001	0.027
Cobalt		—	0.001
Copper		0.021	0.031
Lead		0.001	0.006
Molybdenum		0.001	0.002
Nickel		0.003	0.010
Selenium		<0.001	<0.001
Silver		—	0.016
Strontium		0.025	0.018
Vanadium		0.005	0.012
Zinc		0.35	0.73

Source: Martinelia 1975.

[a]Concentrations are mg/l unless otherwise indicated.

[b]Water collected during snowmelt by an implace sampling jar.

[c]Water collected after a rain event by an implace sampling jar.

TABLE 2.4-10

ELEMENT CONTENT IN SEDIMENTS FROM A TRIBUTARY OF LITTLE LIGHTNING CREEK AND IN SOIL FROM THE PLANT SITE

Element	Concentration	
	Site 1 Sediment[a]	Composite Soil[b]
Aluminum	>0.5%	3.0%
Antimony	1.3	0.32
Arsenic	5.7	5.3
Barium	160	630
Beryllium	0.21	3.6
Boron	87	25
Calcium	0.46%	0.42%
Cadmium	0.75	0.86
Chlorine	190	86
Chromium	56	48
Cobalt	7.7	4.5
Copper	45	17
Fluorine	0.27%	0.07%
Iron	>1%	1.6%
Lead	50	36
Magnesium	>1%	0.26%
Manganese	190	100
Mercury	<0.10	0.06
Molybdenum	1.7	2.6
Nickel	25	3.4
Phosphorus	>0.5%	0.34%
Potassium	>0.5%	1.7%
Selenium	0.69	0.63
Silicon	>1%	36.3%
Silver	0.17	0.18
Sodium	>1%	0.73%
Sulfur	0.09%	0.08%
Titanium	0.12%	0.12%
Thorium	22	7.9
Uranium	16	3.1
Vanadium	32	37
Zinc	160	45

Source: Metronics 1975.
Concentrations are in ppm unless otherwise indicated.
[a]Sampled April 25, 1975.
[b]Analysis of composite samples taken in August 1974.

TABLE 3.4-10

ELEMENT CONTENT IN SEDIMENTS FROM A TRIBUTARY OF LITTLE
LAGUNITAS CREEK AND IN SOIL FROM THE PLANT SITE

Element	Concentration	
	Site 1 Sediment[a]	Composite Soil[b]
Aluminum	>0.5%	3.0%
Antimony	1.3	0.32
Arsenic	5.7	5.3
Barium	180	620
Beryllium	0.2%	3.6
Boron	57	55
Calcium	0.44%	0.42%
Cadmium	0.73	0.86
Chlorine	100	86
Chromium	56	45
Cobalt	7.7	4.3
Copper	45	17
Fluorine	0.22%	0.07%
Iron	>1%	1.4%
Lead	30	26
Magnesium	>1%	0.22%
Manganese	190	100
Mercury	<0.10	0.06
Molybdenum	1.7	2.6
Nickel	35	3.4
Phosphorus	>0.5%	0.14%
Potassium	>0.5%	1.2%
Selenium	0.49	0.6%
Silicon	>1%	34.3%
Silver	0.17	0.18
Sodium	>1%	0.72%
Sulfur	0.03%	0.06%
Titanium	0.11%	0.1%
Thorium	32	7.3
Tungsten	16	1.1
Vanadium	32	37
Zinc	160	43

Source: Metcorp Ltd.
Concentrations are in ppm unless otherwise indicated.
[a]Sampled April 25, 1972.
[b]Analysis of composite samples taken in August 1974.

TABLE 2.4-11

STREAM CROSSINGS BY PROPOSED PROJECT COMPONENTS

Stream Crossing	County	Linear Feature	Stream Classification	Suspended Solids (mg/l) mean	Suspended Solids (mg/l) max	Mean TDS (mg/l)	Average flow
Major Streams							
North Platte River	Platte	Product Pipeline	Class II	--	--	457	1,500 cfs
North Platte River	Converse	Water Pipeline	Class II	845	62,500	438	1,500 cfs
Laramie River	Platte	Product Pipeline	Class II	99	2,240	528	136 cfs
Minor Perennial Streams							
LaPrele Creek	Converse	Water Pipeline	Class II	--	--	--	6 cfs
Bear Creek	Laramie	Product Pipeline	Class II	--	--	--	?
Little Bear Creek	Laramie	Product Pipeline	Class II	--	--	--	?
Horse Creek	Laramie	Product Pipeline	Class II	--	--	--	?
Lodgepole Creek	Laramie	Product Pipeline	Class II	--	--	--	?
Crow Creek	Laramie	Product Pipeline	Class II	--	--	--	?
Large Intermittent Streams							
Muddy Creek	Platte	Product Pipeline	Class II	--	--	--	?
Lightning Creek	Converse	Railroad	Class IV	147	147	1,430	?
Dry Fork of Cheyenne	Converse	Railroad	Class IV	1,896	15,300	1,338	?
Antelope Creek	Converse	Railroad	Class II	128	1,130	1,670	?
Porcupine Creek	Converse	Railroad	Class IV	143	472	1,527	1-7

ANNEX 5-11

AIRBORNE CONDITIONS TO ASSURED SERVICE COMMENCEMENT

Airborne Conditions	Result	Airborne Services	Characterization Criteria	Delay Band (min)			Delay Band (min)	
				Min	Max	Mean	Min	Max
Danger Inflation								
Danger Inflation Error	Alerting	Emergency Information	Class II	—	—	120		
Danger Inflation Error	Conflicts	Minor Information	Class II	240	1,200	810		
Danger Inflation Error	Conflicts	Emergency Information	Class II	89	1,040	310		
Flight Plan Processing Failures								
Lost Flight Plan	Conflicts	Minor Information	Class II	—	—	—		5 min
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Flight Plan Processing Failures								
Lost Flight Plan	Alerting	Emergency Information	Class II	—	—	120		
Wrong Flight Plan Error	Conflicts	Minor Information	Class II	240	12,000	810		
Wrong Flight Plan Error	Alerting	Emergency Information	Class II	89	1,040	310		
Flight Plan Processing Failures								
Lost Flight Plan	Conflicts	Minor Information	Class II	—	—	—		5 min
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Flight Plan Processing Failures								
Lost Flight Plan	Alerting	Emergency Information	Class II	—	—	120		
Wrong Flight Plan Error	Conflicts	Minor Information	Class II	240	12,000	810		
Wrong Flight Plan Error	Alerting	Emergency Information	Class II	89	1,040	310		
Flight Plan Processing Failures								
Lost Flight Plan	Conflicts	Minor Information	Class II	—	—	—		5 min
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Lost Flight Plan	Conflicts	Emergency Information	Class II	—	—	—		2
Flight Plan Processing Failures								
Lost Flight Plan	Alerting	Emergency Information	Class II	—	—	120		
Wrong Flight Plan Error	Conflicts	Minor Information	Class II	240	12,000	810		
Wrong Flight Plan Error	Alerting	Emergency Information	Class II	89	1,040	310		

Ground Water

Mine. The major aquifers in the vicinity of the proposed mine are the alluvial deposits in the creek valleys; the Roland coal seam; sandstone beds in the Wasatch and Fort Union Formations; the Lance and Fox Hills formations; the Inyan Kara Group; and the Madison Group. The regional hydrogeologic setting of the major aquifers in Campbell and Converse counties, Wyoming, has been described in the Final Environmental Impact Statement for Eastern Powder River Coal (BLM 1979).

All domestic and stock wells in the vicinity of the proposed mine site obtain water from the alluvial deposits, the Roland coal seam, and the sandstone beds in the Wasatch and the upper member of the Fort Union Formation. Water yields from these strata are typically in the range of 1 to 50 gpm. Although larger yields could be obtained from deeper aquifers, the costs would be very high. The proposed mine would affect only aquifers in the alluvial deposits and in the Fort Union Formation; there would be no impact on deeper aquifers.

Aquifer Units. Mappable alluvial deposits exist near the permit area in the valleys of the West Fork of Beckwith Creek and Porcupine Creek. The alluvial deposits are lithologically variable, containing lenticular deposits of fine sand, silt, clay, and clinker gravels; the dominant particle size by visual inspection is very coarse sand to medium gravel. The deposits vary in thickness; they are reported by Rochelle Coal Company (1981) to be as deep as 40 feet in the Porcupine Creek valley and 27 feet in Beckwith Creek. The hydraulic conductivity of the alluvial deposits has been estimated to range from 0.2 to 66 feet per day (Table 2.4-12).

The Wasatch Formation, which overlies the Roland coal, consists of highly lenticular beds of fine- to coarse-grained sandstone with

TABLE 2.4-12

HYDROGEOLOGIC PROPERTIES OF AQUIFER UNITS IN THE VICINITY OF THE ROCHELLE COAL MINE

Aquifer Unit	Thickness (feet)	Number of Wells Tested	Hydraulic Conductivity mean	Hydraulic Conductivity minimum	Hydraulic Conductivity maximum	Storage Coefficient
Porcupine Creek Alluvium[a]	0 - 40	13	11.2	.2	66	4×10^{-3}
Beckwith Creek Alluvium[b]	0 - 27	2	2.5	2	3	
Roland Coal[a]	30 - 80	35	.12(7.2)[c]	.02	44	$3 \times 10^{-3} - 2 \times 10^{-3}$
Roland Clinker[a]	0 - 240	1	2,500	--	--	
Wasatch Formation[a]	0 - 250	43	0.30	.005	10	$2.5 \times 10^{-2} - 1.6 \times 10^{-5}$
Fort Union Formation[d] below Roland Coal	2,500	0	2	--	--	

[a]North Antelope Coal Company 1981.

[b]Rochelle Coal Company 1981.

[c]Hydraulic conductivities in the Roland Coal at the North Antelope Mine apparently have a bimodal distribution; refer to text.

[d]Estimated.

TABLE 2.4-12

HYDROGEOLOGIC PROPERTIES OF AQUIFER UNITS IN
THE VICINITY OF THE ROCKVILLE COAL MINE

Aquifer Unit	Thickness (feet)	Number of Wells Tested	Hydraulic Conductivity mean	minimum	maximum	Storage Coefficient
Porcupine Creek Alluvium[a]	0 - 40	13	11.2	.2	66	4×10^{-2}
Rockville Creek Alluvium[b]	0 - 37	1	3.5	2	3	
Roland Coal[a]	30 - 80	15	.12(1.2)[c]	.02	44	$3 \times 10^{-1} - 3 \times 10^{-3}$
Roland Clinker[a]	0 - 240	1	2,500	—	—	
Hassett Formation[a]	0 - 130	43	0.38	.005	10	$2.3 \times 10^{-2} - 1.8 \times 10^{-3}$
Fort Union Formation[d] below Roland Coal	3,300	0	1	—	—	

[a]North American Coal Company 1981.

[b]Rockville Coal Company 1981.

[c]Hydraulic conductivities in the Roland Coal at the North Antelope Mine apparently have a bimodal distribution; refer to text.

[d]Estimated.

interbeds of coal and shale. It is about 80 percent clay-shale and 20 percent lenticular sandstone, and ranges in thickness from 0 to 250 feet. The surface stratum over most of the Rochelle Mine permit area is part of the Wasatch Formation. The hydraulic conductivity of selected intervals of the Wasatch Formation in the area has been estimated to range between 0.005 and 10 feet per day (North Antelope Coal Company 1980).

The Roland coal at the Rochelle Mine site ranges from about 30 to 80 feet thick. In some areas it is a single coal seam, while in others it is parted by thin interbedded shales. The southern and eastern extent of the Roland coal is defined by thick clinker beds that formed when the Roland coal seam burned.

The hydraulic conductivity of this seam at the adjacent North Antelope Mine has been estimated at between 0.02 and 44 feet per day. In the northeastern part of the North Antelope Mine area, where the coal is apparently extensively fractured, the hydraulic conductivity averaged 8.2 ft/day; in the southern part it averaged 0.12 ft/day (North Antelope Coal Company 1980). The coal in the western part of the Rochelle mine area is probably highly fractured. The fracturing at both mines may be due to proximity to the Corder Creek fault.

Clinker deposits are found adjacent to the Roland coal outcrop northeast, east, and south of the Rochelle Mine area. The clinkers formed when the Roland coal seam burned, probably in the Pleistocene epoch (Woessher et al. 1980). Clinker beds are generally two to four times thicker than the coal seams that burned (Matsen and Blumer 1973). The transmissivity of clinkers is generally very high because they are highly fractured and very porous. A hydraulic conductivity of 2,500 ft/day has been calculated from a pump test at a clinker well at the adjacent North Antelope Mine (Table 2.4-12).

interbeds of coal and shale. It is about 80 percent clay-shale and 20 percent lenticular sandstone, and ranges in thickness from 0 to 750 feet. The surface aircrum over most of the Rochelle Mine permit area is part of the Wasatch formation. The hydraulic conductivity of selected laterals of the Wasatch formation in the area has been estimated to range between 0.005 and 10 feet per day (North Antelope Coal Company 1980).

The Roland coal at the Rochelle Mine site ranges from about 30 to 80 feet thick. In some areas it is a single coal seam, while in others it is parted by thin interbedded shales. The southern and eastern extent of the Roland coal is defined by thick clinker beds that formed when the Roland coal seam burned.

The hydraulic conductivity of this seam at the adjacent North Antelope Mine has been estimated at between 0.02 and 34 feet per day. In the northeastern part of the North Antelope Mine area, where the coal is apparently extensively fractured, the hydraulic conductivity averaged 2.2 ft/day; in the southern part it averaged 0.12 ft/day (North Antelope Coal Company 1980). The coal in the western part of the Rochelle mine area is probably highly fractured. The fracturing at both mines may be due to proximity to the Gordon Creek fault.

Clinker deposits are found adjacent to the Roland coal outcrop northeast, east, and south of the Rochelle Mine area. The clinkers formed when the Roland coal seam burned, probably in the Pleistocene epoch (Woodmansee et al. 1980). Clinker beds are generally two to four times thicker than the coal seams that burned (Matson and Blaser 1972). The transmissivity of clinkers is generally very high because they are highly fractured and very porous. A hydraulic conductivity of 2,500 ft/day has been calculated from a pump test at a clinker well at the adjacent North Antelope Mine (Table 2.6-12).

The Fort Union Formation in the vicinity of the permit area is approximately 2,500 feet thick, and consists of approximately 10 major coal beds separated by shales, clays, and discontinuous sandstone lenses. Only the upper 100 feet of the formation in the vicinity of the Rochelle Mine has been described; its transmissivity was estimated to be between 0.20 and 1.57 square feet per day (Rochelle Coal Company 1981). Tests were made in only one location, and it is likely that larger values would be found in other localities.

Ground-Water Movement. A complex series of ground-water flow systems exists in the area, predominately controlled by local geology and topography (Figure 2.4-9). The Roland coal is confined north and west of the permit area. The Wasatch Formation and the Roland coal are only partially saturated, and may be dry over much of the area. In areas where they are not dry, ground water in the Wasatch Formation is often perched over a water table in the Roland coal; and in some areas the water table in the Roland coal is perched above the water table in the Fort Union Formation. Ground water apparently moves from the clinker zones into the Wasatch Formation and the Roland coal, and apparently moves downward from the Wasatch Formation and Roland coal into the Fort Union Formation north and west of the clinker zones (Figure 2.4-10). The clinker zones along the southern and eastern edges of the permit area are generally only partially saturated and ground water apparently moves out of the clinker toward the north and east into the Wasatch Formation and the Roland coal, downward into the Fort Union Formation, and toward the south and east. The shallowest continuous ground-water flow system in the permit area exists in the upper parts of the Fort Union Formation; the general direction of ground-water flow in this formation is north and west from the clinker zones toward Porcupine Creek (Figure 2.4-11).

Discharge and Recharge. Six springs and two flowing wells are the only known discrete points of ground-water discharge in the

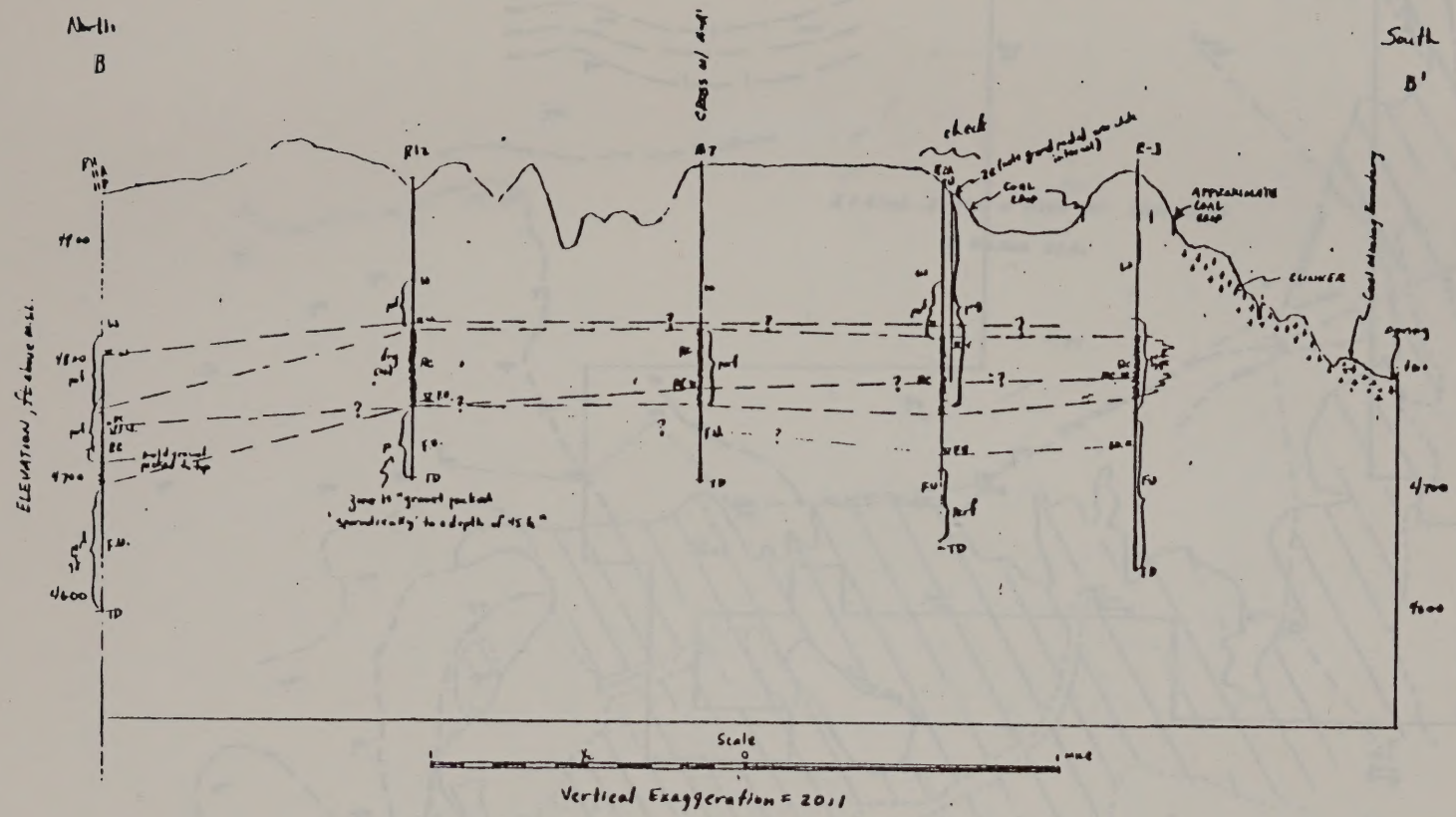


Figure 2.4-9 Schematic of Ground Water Flow Systems in the Vicinity of the Rochelle Mine

LEGEND

- Limits of Roland Coal
- Potentiometric Surface for Wasatch Formation
- Potentiometric Surface for Roland Coal
- Potentiometric Surface for Fort Union Formation
- Clinker

W, RC, FU — Well location; W for Wasatch Formation, RC for Roland Coal, FU for Fort Union Formation. Parentheses indicate zone of perforations and/or gravel pack

W ▽ Water level for Wasatch Formation

RC ▽ Water level for Roland Coal

FU ▽ Water level for Fort Union Formation

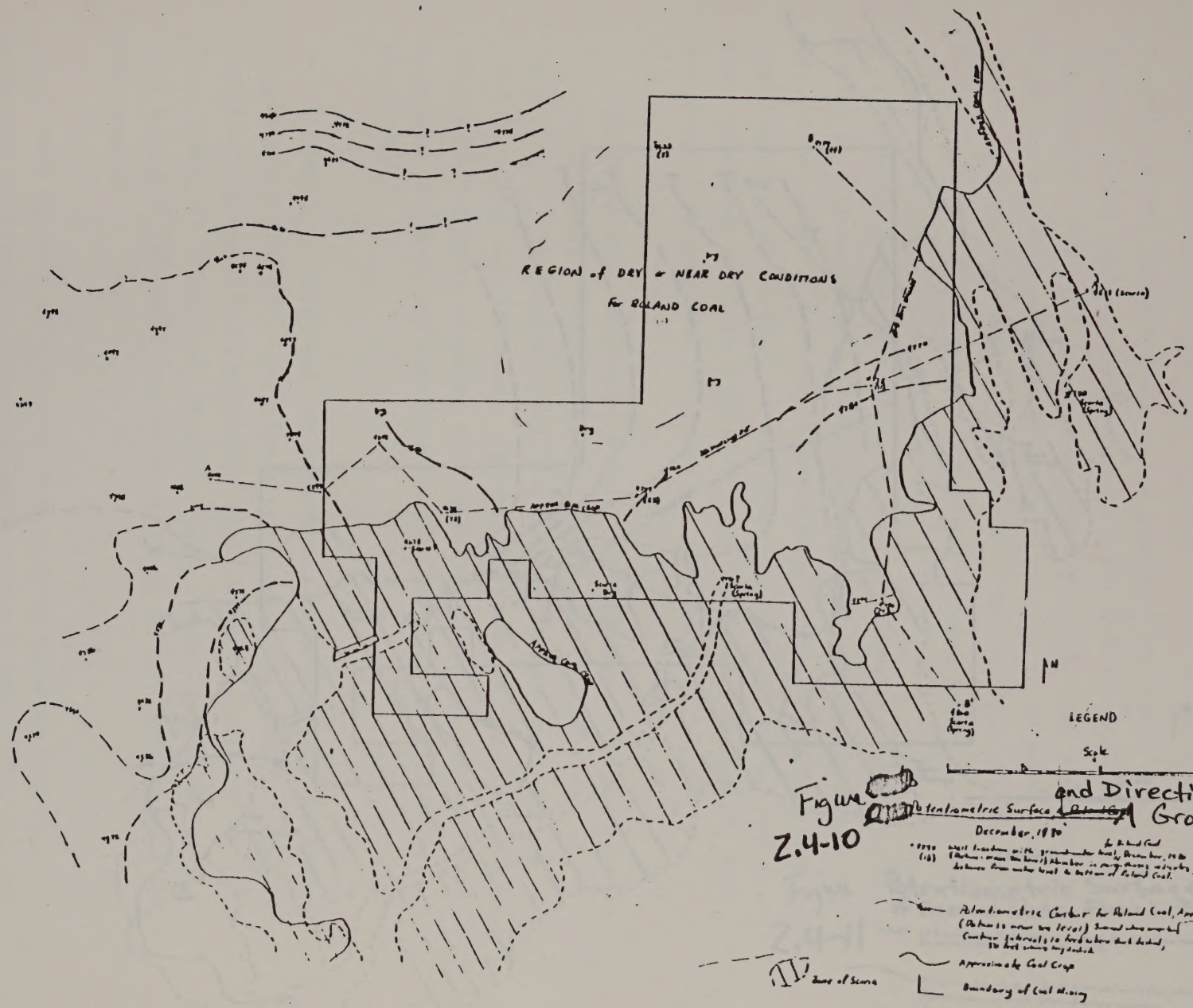


Figure 2.4-10 Potentiometric Surface and Direction of Ground Water Movement in Roland Coal

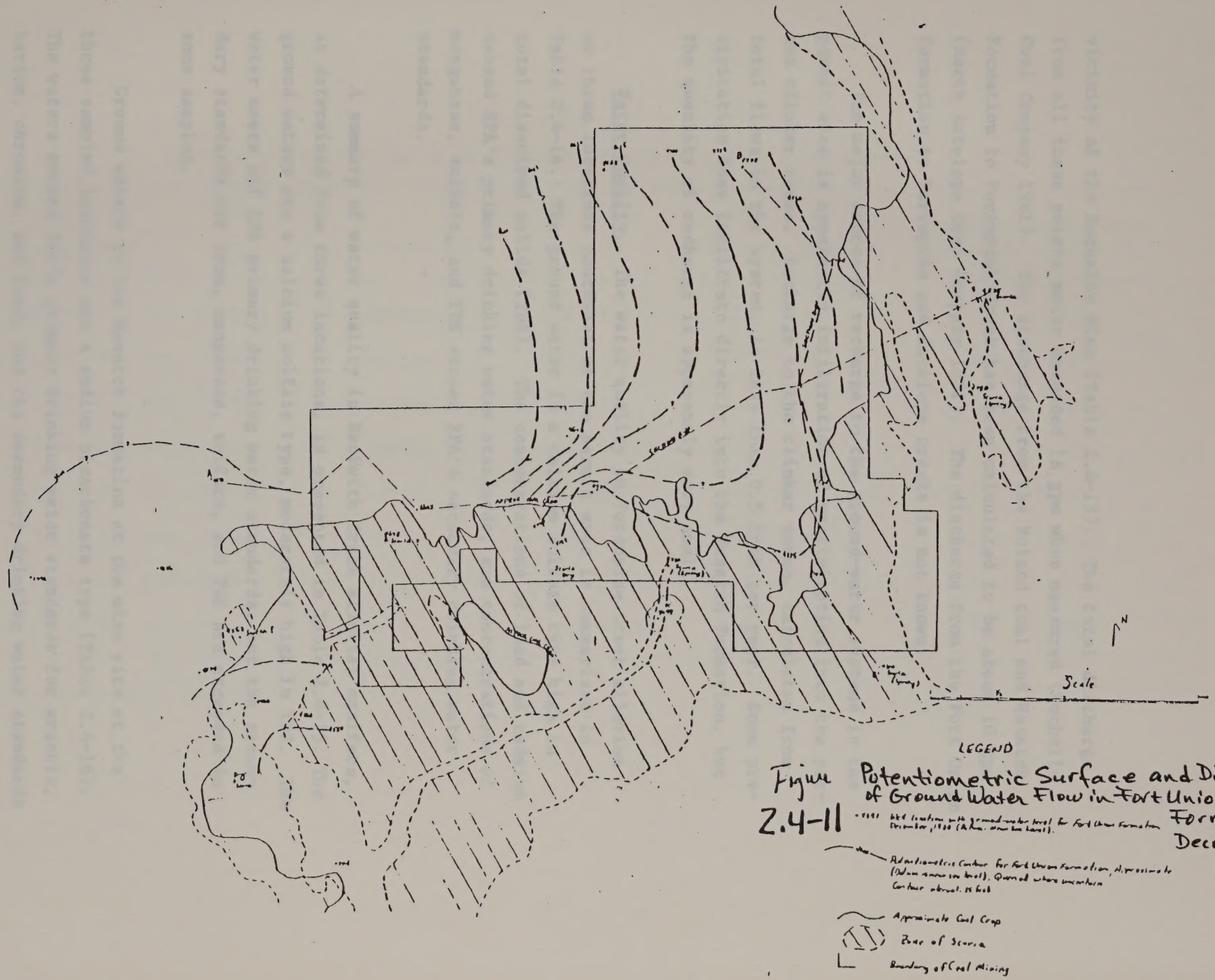


Figure 2.4-11 Potentiometric Surface and Direction of Ground Water Flow in Fort Union Formation, December 1980

vicinity of the Rochelle Mine (Table 2.4-13). The total discharge from all these points never exceeded 18 gpm when measured (Rochelle Coal Company 1981). The discharge from the Roland coal and Wasatch Formation to Porcupine Creek has been calculated to be about 10 gpm (North Antelope Coal Company 1981). The discharge from the Fort Union Formation to Porcupine and Antelope creeks is not known.

The major source of recharge to the ground-water systems in the permit area is apparently infiltration of precipitation into the porous clinker zones. Recharge to the clinker zones, calculated from total flows in the system, is less than 0.5 inch per year. Some precipitation does infiltrate directly into the Wasatch Formation, but the quantity of recharge is apparently very small.

Water Quality. The water quality in Porcupine Creek alluvium at three locations southwest of the permit area is summarized in Table 2.4-14. The ground water is a calcium sulfate type high in total dissolved solids (TDS). The concentrations of lead and cadmium exceed EPA's primary drinking water standards, and concentrations of manganese, sulfate, and TDS exceed EPA's secondary drinking water standards.

A summary of water quality in Beckwith Creek alluvial aquifers, as determined from three locations, is presented in Table 2.4-15. The ground waters are a calcium sulfate type, moderately high in TDS. The water meets all EPA primary drinking water standards, but the secondary standards for iron, manganese, sulfate, and TDS are exceeded in some samples.

Ground waters in the Wasatch Formation at the mine site at the three sampled locations are a sodium bicarbonate type (Table 2.4-16). The waters exceed EPA's primary drinking water standards for arsenic, barium, chromium, and lead, and the secondary drinking water standards

TABLE 2.4-13

SPRINGS AND FLOWING WELLS IN VICINITY OF ROCHELLE MINE PERMIT AREA

Location	Spring or Well	Source	Discharge (gpm)	Specific Conductance (μmhos at 25°C)
T. 41 N., R. 70 W., Sec. 12dcc	Spring	Clinker	0 - 6.3	105 - 3,000
T. 41 N., R. 69 W., Sec. 5dbd	Spring	Clinker	0 - 0.25	200 - 650
T. 41 N., R. 69 W., Sec. 17cbb	Spring	Clinker	4 - 8.6	700 - 1,200
T. 42 N., R. 69 W., Sec. 28caa	Spring	Ft. Union	0.3 - 0.375	2,300
T. 42 N., R. 70 W., Sec. 23dad	Spring	Wasatch	trace	2,400 - 2,700
T. 42 N., R. 70 W., Sec. 23dad	Spring	Wasatch	.012 - 0.4	1,100 - 1,300
T. 41 N., R. 70 W., Sec. 16ddc	Well	Ft. Union	1.6 - 2.0	270 - 682
T. 41 N., R. 70 W., Sec. 9bcb	Well	Ft. Union	12 - 17	300 - 1,200

Source: Rochelle Coal Company, 1981.

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11-6.2 STATT

LAKE STORRY SEEN BELOW POCHOTTE KEEN AREAS IN ALGERIA TO PROVIDE MEAN DAILY RAINFALL

Location	Source of Data	Source	Discrepancy (km)	Specific Conductance (µmhos at 25°C)
Ait Ouarzeddine	Sonatrach	Clinkenbeard	0 - 0.3	100 - 2,000
Ait Ouarzeddine	Sonatrach	Clinkenbeard	0 - 0.32	300 - 870
Ait Ouarzeddine	Sonatrach	Sonatrach	0.8 - 2	100 - 1,200
Ait Ouarzeddine	Sonatrach	Sonatrach	0.3 - 0.312	2,300
Ait Ouarzeddine	Sonatrach	Sonatrach	2.5	2,000 - 3,100
Ait Ouarzeddine	Sonatrach	Clinkenbeard	4.0 - 5.9	1,100 - 2,300
Ait Ouarzeddine	Sonatrach	Sonatrach	0.5 - 8.1	280 - 310
Ait Ouarzeddine	Sonatrach	Sonatrach	11 - 11	200 - 1,200

Source: Sonatrach Oil Company 1981

TABLE 2.4-14

WATER QUALITY IN THE PORCUPINE CREEK ALLUVIUM IN THE VICINITY OF THE ROCHELLE COAL MINE PERMIT AREA

	Number of Samples	Maximum Value	Minimum Value	Mean	Standard Deviation
FIELD PARAMETERS					
Temperature (°C)	10	12.0	7.5	9.5	1.4
Conductivity (μmho/cm at 25°)	10	4,851.0	1,350.0	3,176.8	938.7
ph (units)	10	7.5	6.7	7.0	$10^{-7.2}$
LABORATORY PARAMETERS[a]					
Acidity (As $CaCO_3$)[b]	10	-421.0	-129.0	-373.1	-88.3
Alkalinity (As $CaCO_3$)	10	506.0	323.0	440.3	43.5
Aluminum	11	18.0	0.4	5.2	5.9
Arsenic	11	0.025	.001[e]	0.008	0.008
Barium	3	0.2	0.2	0.2	0.00
Bicarbonate	10	506.0	323.0	440.3	43.5
Boron	11	0.42	0.051	0.20	0.12
Cadmium	11	0.024	.011[e]	0.014	0.004
Calcium	11	450.0	122.0	373.1	104.1
Chloride	10	24.0	5.0	14.6	6.1
Chromium	11	0.06	0.03	0.04	0.01
Conductivity (μmho/cm at 25°C)	10	4,330.0	1,020.0	2,275.3	1,020.7
Copper	11	0.15	0.04	0.07	0.03
Fluoride	10	1.00	0.55	0.67	0.12
Hardness	11	1,898.0	549.0	1,502.5	366.7
Iron	11	0.26	.05[e]	0.07	0.06
Lead	11	0.24	0.04	0.10	0.07
Magnesium	11	174.0	56.0	138.5	31.5
Manganese	11	1.87	0.02	0.54	0.57
Mercury	11	0.58	.02[e]	0.14	0.17
Molybdenum	7	0.2	.1[e]	0.14	0.05
Nickel	11	0.07	.05[e]	0.06	0.00
Nitrogen-Kjeldahl	10	6.54	0.20	1.47	1.75
Nitrogen-Ammonia	10	1.23	.10[e]	0.24	0.33
Nitrate + Nitrite[c]	10	1.78	0.03	0.41	0.49
pH (Units)	10	8.1	7.4	7.6	$10^{-7.9}$
Phosphorous	10	4.23	0.01	0.54	1.24
Potassium	11	18.0	5.0	11.3	4.3
SAR (Unitless)	11	6.17	2.73	4.27	1.47
Selenium	11	0.01	.001[e]	0.002	0.002
Sodium	11	586.0	174.0	384.7	168.3
Solids, Total Dissolved	9	4,164.0	1,130.0	2,889.4	922.5
Sulfate	10	2,553.0	610.0	1,372.7	676.3
Zinc	11	0.53	0.04	0.13	0.13
Cation-Anion Balance (%)[d]	9	24.7	7.7	8.5	11.9

[a] All measurements are in milligrams per liter (mg/l) dissolved constituents unless otherwise noted.
[b] Negative acidity indicates that the water is alkaline.
[c] Nitrate ion concentration only.
[d] A negative balance indicates that anions exceed cations.
[e] Indicates concentrations below analytical detection limits.

TABLE 2.4-14

WATER QUALITY IN THE MONONGAHELA CHEMICAL ALLEY/VIEW IN THE VICINITY OF THE MONONGAHELA COAL MINE ECONOMY AREA

	Number of Samples	Minimum Value	Maximum Value	Mean	Standard Deviation
FIELD PARAMETERS					
Temperature (°C)	10	12.0	2.5	9.5	1.4
Conductivity (umhos/cm at 25°C)	10	4,800.0	1,190.0	2,174.4	928.7
pH (units)	10	7.5	6.7	7.8	10
LABORATORY PARAMETERS*					
Acidity (as $CaCO_3$)*	10	-4,[illegible]	-120.0	-173.1	-[illegible]
Alkalinity (as $CaCO_3$)	10	704.0	320.0	440.3	43.3
Aluminum	11	0.0	0.4	3.1	2.4
Arsenic	11	3.[illegible]	.001*	0.004	0.006
Barium	3	0.2	0.1	0.2	0.00
Bicarbonate	10	704.0	320.0	440.3	43.3
Boron	11	0.[illegible]	0.031	0.20	0.12
Cadmium	11	0.004	.011*	0.014	0.004
Calcium	11	440.0	122.0	272.1	104.1
Chloride	10	14.0	2.0	14.6	4.1
Chromium	11	0.06	0.03	0.04	0.01
Conductivity (umhos/cm at 25°C)	10	4,320.0	1,450.0	2,125.3	[illegible]
Copper	11	0.13	0.04	0.07	0.03
Fluoride	10	1.00	0.35	0.61	0.22
Hardness	11	1,[illegible]	544.0	1,[illegible]	386.[illegible]
Iron	11	0.[illegible]	.04*	0.07	0.04
Lead	11	0.14	0.04	0.10	0.07
Magnesium	11	174.0	38.0	122.3	41.2
Manganese	11	1.47	0.07	0.94	0.27
Mercury	11	0.14	.0[illegible]*	0.14	0.13
Molybdenum	7	0.7	.4*	0.14	0.03
Nickel	11	0.31	.03*	0.09	0.03
Nitrogen-Ammonia	10	5.34	0.34	2.47	1.73
Nitrogen-Nitrate	10	1.23	.10*	0.34	0.23
Nitrate - Nitrite*	10	1.14	0.10	0.61	0.43
pH (units)	10	4.1	2.6	3.6	10
Phosphorous	10	1.14	0.21	0.54	1.34
Potassium	11	18.0	2.0	11.3	4.3
Sum (Cations)	11	9.1[illegible]	3.73	6.17	1.47
Selenium	11	0.01	.005*	0.005	0.002
Sodium	11	154.0	134.0	134.7	148.1
Sulfate, Total Dissolved	4	4,104.0	1,130.0	2,809.0	921.4
Sulfide	10	2,372.0	510.0	1,372.7	476.3
Zinc	11	0.[illegible]	0.04	0.12	0.15
Cation-Anion Balance (%)*	9	14.1	7.7	8.3	11.8

*Measurements are in milligrams per liter (mg/l) dissolved chemicals unless otherwise noted.
*Negative acidity indicates that the value is alkaline.
*Nitrate ion concentration only.
*A negative balance indicates that anions exceed cations.
*Minimum concentrations below analytical extractive limits.

TABLE 2.4-15

WATER QUALITY IN THE ALLUVIUM OF BECKWITH CREEK AND TRIBUTARIES IN VICINITY OF ROCHELLE COAL MINE PERMIT AREA

	Well A1			Well A2			Well A3		
	No. of Samples	Mean	Std. Dev.	No. of Samples	Mean	Std. Dev.	No. of Samples	Mean	Std. Dev.
FIELD PARAMETERS									
Conductivity (μmhos/cm at 25°C)	4	1,299.43	16.56	4	383.5	62.85	4	1,219.55	575.82
pH (units)	4	6.8	NA	4	6.72	NA	4	6.77	NA
Water Temperature (C)	4	11.38	1.9	4	13.2	2.66	4	11.88	2.12
LABORATORY PARAMETERS[a]									
Acidity (as $CaCO_3$)	3	-153	-24.02	3	-57.67	-45.37	3	-152.67	-19.5
Alkalinity (as $CaCO_3$)	4	176.5	16.03	4	83.75	42.79	4	172.5	9.47
Aluminum	4	.35	.24	4	.45	.5	3	.27	.12
Arsenic	4	0	0	4	0	0	4	0	0
Barium	4	.2	0	4	.2	0	4	.2	0
Bicarbonate	4	215.2	19.55	4	102.13	52.17	4	210.3	11.56
Boron	4	.4	.12	4	.25	.11	4	.87	.09
Cadium	4	0	0	4	0	0	4	0	0
Calcium	4	151.25	8.34	4	54.25	1.5	4	226	4.4
Chloride	4	7	.82	4	4	.82	4	7	.82
Chromium	4	.03	.01	4	.03	.01	4	.03	0.1
Conductivity (μmhos/cm at 25°C	4	1,513.75	25.62	4	564	12.41	4	1,679.25	51.01
Copper	4	.02	0	4	.02	0	4	.02	0
Fluoride	4	.47	.21	4	.45	.05	4	.67	.06
Hardness (as $CaCO_3$)	4	696.5	19.02	4	235	8.29	4	950	20.41
Iron (dissolved)	3	.22	.24	3	.05	.05	3	.03	.01
Iron (total)	4	1.08	1.34	4	.7	1.28	4	.14	.14
Lead	4	.02	0	4	.02	0	4	.02	0
Magnesium	4	79.25	15.31	4	26.25	5.97	4	98.5	15.29
Manganese	4	.49	.06	4	.08	.07	4	.04	.02
Mercury (μg/l)	4	.02	0	4	.02	0	4	.02	0
Molybdenum	4	.2	0	4	.2	0	4	.2	0
Nickel	4	.03	.01	4	.02	0	4	.02	0
Nitrogen - Kjeldahl	4	.88	.1	4	.48	.34	4	.44	.13
Nitrogen - Ammonia	4	.83	.15	4	.23	.15	4	.14	.07
Nitrate as N	1	1.2	0	1	1.95	0	1	6	0
Nitrate + Nitrite as N	3	.71	.87	3	1.93	.7	3	1.82	.15
pH (units)	4	7.4	NA	4	7.41	NA	4	7.49	NA
Phosphorus	4	.03	.03	4	.03	.03	4	.02	.01
Potassium	4	16	1.83	4	8.5	1	4	26.5	3.11
SAR (units)	4	2.04	1.11	4	.74	.08	4	.62	.03
Selenium	4	0	0	4	0	0	4	0	0
Silica	3	14.07	.67	3	15.17	2.67	3	12.97	.85
Sodium	4	123.75	64.4	4	26.5	1.91	4	44.5	2.52
Solids, Total Dissolved	4	1,258.75	40.71	4	446.75	56.47	4	1,494.75	23.8
Sulfate	4	736	55.72	4	195.75	14.36	4	875.75	32.2
Zinc	4	.04	.01	4	.03	.01	4	.04	.01
Cation-Anion Balance									

[a]All concentrations in milligram per liter (mg/l) dissolved constituents, unless otherwise noted.

TABLE 3.4-13

WATER QUALITY IN THE ALLUVIUM OF BROWNSVILLE CREEK AND TRIBUTARIES IN VICINITY OF BONNELLE COAL MINE PERMIT AREA

	Well #1			Well #2			Well #3		
	No. of Samples	Mean	Std. Dev.	No. of Samples	Mean	Std. Dev.	No. of Samples	Mean	Std. Dev.
FIELD PARAMETERS									
Conductivity (umhos/cm at 25°C)	4	1,199.63	16.56	4	324.5	62.85	4	1,219.55	517.82
pH (units)	4	6.8	NA	4	6.72	NA	4	6.77	NA
Water Temperature (C)	4	11.32	1.5	4	13.2	2.86	4	11.66	2.12
LABORATORY PARAMETERS*									
Acidity (as $CaCO_3$)	3	-171	-24.02	3	-71.67	-45.17	3	-152.67	-19.3
Alkalinity (as $CaCO_3$)	4	175.5	16.03	4	83.75	42.79	4	172.3	6.47
Aluminum	4	.75	.26	4	.65	.5	3	.27	.12
Arsenic	4	0	0	4	0	0	4	0	0
Barium	4	.2	0	4	.1	0	4	.1	0
Bicarbonate	4	213.2	19.55	4	102.15	52.17	4	210.3	11.34
Boron	4	.4	.12	4	.15	.11	4	.47	.09
Cadmium	4	0	0	4	0	0	4	0	0
Calcium	4	131.25	8.34	4	54.25	1.5	4	224	4.4
Chloride	4	7	.82	4	4	.82	4	7	.82
Chromium	4	.03	.01	4	.03	.01	4	.03	0.1
Conductivity (umhos/cm at 25°C)	4	1,313.75	23.82	4	764	12.41	4	1,819.25	31.01
Copper	4	.02	0	4	.02	0	4	.02	0
Fluoride	4	.47	.21	4	.45	.05	4	.67	.08
Hardness (as $CaCO_3$)	4	698.5	19.02	4	325	8.29	4	950	20.41
Iron (glassware)	3	.22	.24	3	.05	.03	3	.03	.01
Iron (total)	4	1.08	1.44	4	.7	1.32	4	.14	.14
Lead	4	.02	0	4	.02	0	4	.02	0
Magnesium	4	79.25	13.31	4	36.25	5.57	4	98.5	15.39
Manganese	4	.49	.06	4	.08	.07	4	.04	.01
Mercury (ug/l)	4	.02	0	4	.02	0	4	.02	0
Molybdenum	4	.2	0	4	.2	0	4	.2	0
Nickel	4	.03	.01	4	.02	0	4	.03	0
Nitrogen - Kjeldahl	4	.58	.1	4	.48	.34	4	.44	.13
Nitrogen - Ammonia	4	.85	.12	4	.23	.15	4	.14	.07
Nitrate as N	1	1.2	8	1	1.95	0	1	4	0
Nitrite + Nitrite as N	3	.71	.87	3	1.22	.7	3	1.82	.15
Oil (total)	4	7.4	—	4	7.41	NA	4	7.49	NA
Phosphorus	4	.03	.03	4	.02	.02	4	.02	.01
Potassium	4	14	1.43	4	8.5	1	4	26.5	3.11
TKN (total)	4	2.04	1.11	4	.74	.08	4	.63	.03
Selenium	4	0	0	4	0	0	4	0	0
Silica	3	14.67	.67	3	15.17	2.87	3	12.97	.85
Sodium	4	123.75	64.4	4	24.5	1.91	4	44.5	2.52
Solids, Total Dissolved	4	1,158.25	40.71	4	444.75	32.47	4	1,494.75	23.8
Sulfate	4	238	33.72	4	193.75	16.38	4	875.75	22.2
Zinc	4	.04	.01	4	.03	.01	4	.04	.03
Cation-Anion Balance									

*All concentrations in milligrams per liter (mg/l) dissolved constituents, unless otherwise noted.

for manganese, sulfate, TDS, and iron. These ground waters are suitable for livestock and irrigation, but only of salt-tolerant plants.

No ground-water samples were taken from the Roland coal seam within the permit area because of the limited saturation thickness. Ground-water quality in the Roland coal in the adjacent North Antelope permit area is very similar to that in the Wasatch Formation on the Rochelle permit area (Table 2.4-16).

Water quality in the upper part of the Fort Union Formation is a sodium sulfate bicarbonate type, with TDS ranging between 900 and 3,000 mg/l. These ground waters sometimes exceed EPA's primary drinking water standards for arsenic, barium, cadmium, and lead and the secondary drinking water standards for manganese, sulfate, iron, and TDS. The waters are unsuitable for irrigation because of their high salinity and medium to high sodium hazard, but they are suitable for livestock (Table 2.4-16).

Plant. The major water-bearing strata in the vicinity of the plant site are the sandstone beds in the Wasatch and Fort Union formations. All shallow domestic and stock wells in the vicinity of the plant site are completed in the Wasatch Formation, and a few deep wells are completed in the Fort Union Formation. Well yields range from a few to over 100 gallons per minute. The Wasatch Formation, which may be up to 500 feet thick at the plant site, and the Fort Union Formation, which may be up to 2,500 feet thick at the site, consist of lenticular, fine- to coarse-grained sandstones, claystones, and siltstones. Water levels at the plant site are about 100 feet below land surface.

Ground-water movement in the Wasatch Formation in the plant site area is strongly influenced by topography; flow is away from the topographic high in T. 35 N., R. 70 W., sec. 5, about 2 miles southeast of the plant site, toward Willow Creek to the northeast, toward

for manganese, sulfate, TDS, and iron. These ground waters are suitable for livestock and irrigation, but only of salt-tolerant plants.

No ground-water samples were taken from the Roland coal seam within the permit area because of the limited saturation thickness. Ground-water quality in the Roland coal in the adjacent North Antelope permit area is very similar to that in the Wasatch formation on the Rochelle permit area (Table 2.4-16).

Water quality in the upper part of the Fort Union formation is a sodium sulfate bicarbonate type, with TDS ranging between 900 and 3,000 mg/l. These ground waters sometimes exceed EPA's primary drinking water standards for arsenic, barium, cadmium, and lead and the secondary drinking water standards for manganese, sulfate, iron, and TDS. The waters are unsuitable for irrigation because of their high salinity and sodium to high sodium hazard, but they are suitable for livestock (Table 2.4-16).

Plant. The major water-bearing strata in the vicinity of the plant site are the sandstone beds in the Wasatch and Fort Union formations. All shallow domestic and stock wells in the vicinity of the plant site are completed in the Wasatch formation, and a few deep wells are completed in the Fort Union formation. Well yields range from a few to over 100 gallons per minute. The Wasatch formation, which may be up to 500 feet thick at the plant site, and the Fort Union formation, which may be up to 2,500 feet thick at the site, consist of lenticular, fine- to coarse-grained sandstones, claystones, and siltstones. Water levels at the plant site are about 100 feet below land surface.

Ground-water movement in the Wasatch formation in the plant site area is strongly influenced by topography; flow is away from the topographic high in T. 33 N., R. 10 W., sec. 3, about 2 miles southeast of the plant site, toward Willow Creek to the northeast, toward

TABLE 2.4-16

GROUND WATER QUALITY IN SHALLOW AQUIFERS IN THE ROCHELLE COAL MINE PERMIT AREA

	Fort Union Formation (7 wells)[a]					Roland Coal (3 wells)[b]					Wasatch Formation (3 wells)[a]				
	No. of Samples	Mean	Std. Dev.	Max.	Min.	No. of Samples	Mean	Std. Dev.	Max.	Min.	No. of Samples	Mean	Std. Dev.	Max.	Min.
FIELD PARAMETERS[a]															
Conductivity (µmhos/cm at 25 (C))	28	2,052.52	779.77	3,776	1,168.2	6	3,132.17	3,974.24	9,585	520	10	1,565.65	319.64	1,911	918
pH (units)	28	6.85	NA	11	6.3	7	7.08	NA	7.5	6.8	10	6.87	NA	7.7	6.4
Water Temperatue (C)	28	75.49	325.05	1,734	10.6	7	12.97	.54	13.7	12.1	10	14.32	3.79	21.6	8.9
LABORATORY PARAMETERS[a]															
Acidity (as $CaCO_3$)[b]	21	-627.62	-140.72	-918	-473	4	703.25	161.55	849	546	0	901.25	-251.35	-1,253	-498
Alkalinity (as $CaCO_3$)	28	674.86	146.89	964	495	10	753.4	148.33	900	570	10	1,011	222.45	1,264	524
Aluminum	27	.6	.88	4	.2	11	.36	.3	1	.1	10	7.61	23.33	74	.2
Arsenic	27	.01	.02	.114	1E-03	11	0	0	.014	1E-03	10	.01	.03	.078	1E-03
Barium	28	.31	.35	2	.2	11	.49	.35	1	.14	10	.54	.28	1.2	.2
Bicarbonate	28	822.79	179.07	1,175	603.5	11	897.18	163.39	1,097	695	10	1,232.63	271.2	1541.1	638.9
Boron	28	.23	.08	.381	.075	11	.18	.09	.275	.01	10	.18	.04	.237	.129
Cadmium	28	0	0	.02	2E-03	11	0	0	.01	2E-03	10	0	0	7E-03	2E-03
Calcium	28	92.58	54.59	202	1.33	11	107.65	51.84	190	49.6	10	52.7	22.75	87	11
Chloride	28	14.5	14.06	53	3	11	7.17	5.28	15.8	.2	10	41.3	27.53	92	12
Chromium	27	.03	.01	.04	.02	10	.05	.03	.1	.02	10	.05	.06	.23	.02
Conductivity (µmhos/cm at 25°C	28	2,182.46	689.26	3,810	1346	10	1,809.2	366.6	2,605	1,426	10	1,931.6	329.74	2,700	1,510
Copper	28	.03	.01	.06	.02	11	.02	.01	.04	.01	10	.06	.12	.39	.02
Fluoride	28	.9	.22	1.4	.62	11	1.03	.22	1.31	.78	10	.89	.17	1.14	.63
Hardness (as $CaCO_3$)	28	452.61	243.43	853	67	8	482.38	233.27	838	262	10	273.2	68.11	339	138
Iron (dissolved)	21	.14	.27	1.07	.02	9	.25	.5	1.48	.02	7	.21	.25	.62	.02
Iron (total)	28	.67	.8	2.77	.03	11	8.03	22.16	74.8	.39	10	12.19	31.78	102	.02
Lead	28	.03	.02	.14	.02	11	.03	.01	.05	.01	10	.08	.19	.63	.02
Magnesium	28	54.21	30.62	121	2	11	53.05	24.28	91	28	10	27.9	12.38	53	9
Manganese	27	.06	.04	.22	.02	11	.05	.07	.237	.01	10	.38	.61	1.97	.02
Mercury (g/l)	28	.05	.09	.49	.02	11	.07	.18	.61	1E-03	10	.11	.26	.85	.02
Molybdenum	28	.2	0	.2	.2	11	.17	.05	.2	.1	10	.22	.06	.4	.2
Nickel	28	.03	.02	.08	.02	11	.04	.03	.1	.02	10	.05	.07	.25	.02
Nitrogen - Kjeldahl	28	3.77	.99	5.31	1.58	8	2.89	.51	3.9	2.43	10	16.81	45.4	146	1.42
Nitrogen - Ammonia	28	3.5	1.08	5.44	1.39	11	2.81	.52	3.8	2	10	2.18	.77	3.5	1
Nitrate as N	9	1.75	1.29	4.62	1	3	.11	.12	.24	.01	2	1	0	1	1
Nitrate + Nitrite as N	18	.14	.1	.39	.01	6	.97	.09	1.08	.85	8	.1	.1	.26	.01
pH (units)	28	7.86	NA	11.3	7.5	9	7.24	NA	7.8	6.9	10	7.97	NA	8.3	7.6
Phosphorus	28	.04	.06	.28	.01	9	.03	.03	.1	.01	10	.18	.23	.63	.01
Potassium	28	14.11	4.72	23	6	11	13.16	4.39	20.8	2.5	10	15.4	8.17	29	8
SAR (units)	28	8.05	2.15	13.96	3.99	11	5.72	1.34	7.4	4.02	10	10.35	3.84	20.9	7.78
Selenium	28	0	0	2E-03	1E-03	11	0	0	2E-03	1E-03	10	0	0	1E-03	1E-03
Silica	21	6.03	3.51	16.3	3	9	4.58	1.73	5.6	.1	7	23.47	44.07	123	3.7
Sodium	28	366.07	120.75	668	244	11	269.09	29.26	340	239	10	347.2	60.99	410	206
Solids, Total Dissolved	28	1,628	627.75	3,028	843	11	1,248.27	356.22	1,966	800	10	1,240.7	278.09	1,717	697
Sulfate	28	644.86	436.64	1,582	14	11	381.12	353.7	1,016	25	10	68.5	66.42	235	2
Zinc	28	.06	.07	.36	.02	11	.21	.24	.68	.027	10	.2	.46	1.5	.02

Source: Rochelle Coal Company 1981.

[a]Samples from wells located in Rochelle Mine permit area.

[b]Samples from wells located in North Antelope Mine permit area.

Table 2.4-14

[illegible] WATER QUALITY IN SELECTED AQUIFERS IN THE SCHUYLKILL CREEK, [illegible] AREA

	Raw Water Quality (2 Wells)[a]								Treated Water Quality (2 Wells)[b]								Drinking Standards (2 Wells)[c]			
	No. of Samples	Mean Conc.	Std. Dev.	Min. Conc.	Max. Conc.	No. of Samples	Mean Conc.	Std. Dev.	Min. Conc.	Max. Conc.	No. of Samples	Mean Conc.	Std. Dev.	Min. Conc.	Max. Conc.
[illegible]															
Conductivity															
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
Water Temperature (C)	24	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]															
Alkalinity (as CaCO3)	24	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]	11

Walker Creek to the southeast, and toward tributaries of Little Lightning Creek to the west and northwest. Ground-water movement in the immediate vicinity of the plant site is to the north toward Willow Creek and an unnamed tributary of Little Lightning Creek.

Ground-water quality in the vicinity of the plant site is unknown. Ground-water quality regionally within the Fort Union and Wasatch formations is quite variable, but waters from these formations are generally a sodium bicarbonate type with moderately-high total dissolved solids concentrations (Table 2.4-17).

South Well Field. The South Well Field is located about 12 miles east of Douglas. Near the well-field site, elevations range from about 6,600 feet along a ridge south of the well field and near the heads of Box Elder Canyon and Little Box Elder Creek, to about 5,000 feet in the Platte River floodplain.

The Madison Formation and the Deadwood Formation are the proposed sources of ground water at the South Well Field. These formations outcrop in the southern part of the well field and are approximately 10,000 feet below land surface in the northern part of the well field.

The Paleozoic aquifer system, which is defined for this study to include the Flathead, Madison, and Casper formations, is an important regional source of water. The major water-bearing unit in the aquifer system is the Mississippian-age Madison Group and adjacent hydraulically connected strata. The Madison Group is found in parts of Wyoming, Montana, North and South Dakota, and Canada, covering an area of more than 180,000 square miles. Composed largely of limestone and dolomite, the Madison Group is a source of water for domestic, stock, industrial, and agricultural users. In the Powder River Basin and the Black Hills region, about 30,000 acre-feet per year are produced from the Paleozoic aquifer (WCC 1980). The Paleozoic aquifer has not been

Walker Creek to the southeast, and toward tributaries of Little Lightning Creek to the west and northwest. Ground-water movement in the immediate vicinity of the plant site is to the north toward Willow Creek and an unnamed tributary of Little Lightning Creek.

Ground-water quality in the vicinity of the plant site is unknown. Ground-water quality regionally within the Fort Union and Wasatch formations is quite variable, but waters from these formations are generally a sodium bicarbonate type with moderately-high total dissolved solids concentrations (Table 2.4-17).

South Well Field. The South Well Field is located about 12 miles east of Douglas. Near the well-field site, elevations range from about 6,600 feet along a ridge south of the well field and near the heads of Box Elder Canyon and Little Box Elder Creek, to about 5,000 feet in the Platte River floodplain.

The Madison Formation and the Deadwood Formation are the proposed sources of ground water at the South Well Field. These formations outcrop in the southern part of the well field and are approximately 10,000 feet below land surface in the northern part of the well field.

The Paleozoic aquifer system, which is defined for this study to include the Flathead, Madison, and Casper formations, is an important regional source of water. The major water-bearing unit in the aquifer system is the Mississippian-age Madison Group and adjacent hydraulically connected strata. The Madison Group is found in parts of Wyoming, Montana, North and South Dakota, and Canada, covering an area of more than 150,000 square miles. Composed largely of limestone and dolomite, the Madison Group is a source of water for domestic, stock, industrial, and agricultural users. In the Powder River Basin and the Black Hills region, about 30,000 acre-feet per year are produced from the Paleozoic aquifer (WGC 1980). The Paleozoic aquifer has not been

TABLE 2.4-17

WATER QUALITY IN WATER WELLS NEAR PROPOSED PLANT SITE[a] AND NORTH WELL FIELD[b]

Location		Formation	Well Depth	Sample Date	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	B(μg/l)	SiO_2	TDS (calculated)	pH	°C
T. 34 N., R. 69 W., Sec. 10dd	about 6 miles east of plant site	Fort Union Lebo Member	206	06-05-69	151	64	120	10	178	725	3.1	0.2	0	6.8	1,170	8.0	12.0
T. 34 N., R. 68 W., Sec. 9ddd	about 11 miles east of plant site	Fort Union Lebo Member	190	06-04-69	55	34	224	10	220	525	1.9	0.2	40	7.6	1,030	7.7	12.0
T. 34 N., R. 68 W., Sec. 12bbd	about 14 miles east of plant site	Fort Union Lebo Member	200	06-05-69	32	12	68	7.6	252	70	3.4	0.7	20	7.8	326	8.1	13.0
T. 36 N., R. 69 W., Sec. 24dd	about 11 miles northeast of plant site	Fort Union Lebo Member	434	06-05-69	4.6	3.0	134	2.8	246	102	2.2	0.8	20	7.9	384	8.1	13.0
	about 4 miles southwest of well field	Fort Union Lebo Member	210														
T. 36 N., R. 70 W., Sec. 9ccb	about 12 miles north of plant site	Wasatch	217	06-03-68	93	29	304	4.0	301	745	8.5	0.7	50	11	1,340	7.6	12.0
T. 36 N., R. 72 W., Sec. 9dd	about 6 miles northwest of well field	Wasatch	212	06-06-69	36	8.5	146	2.4	184	278	5.0	0.3	10	11	577	7.7	11.0
T. 36 N., R. 72 W., Sec. 29ba	about 7 miles northwest of well field	Wasatch	400	07-22-69	45	7.0	94	6.0	220	160	4.0	-	-	-	424	6.6	-
T. 36 N., R. 73 W., Sec. 27ba	about 12 miles northwest of well field	Wasatch	180	06-06-69	69	15	53	5.7	260	136	3.8	0.3	20	15	235	7.7	10.0
T. 35 N., R. 71 W., Sec. 23	well field test well	Lance-Fox Hills	6,300	02-25-75	3	1	247	5	610	23	22				601	8.0	58.0

Source: Hodson 1971.

[a]The plant site is in T. 35 N., R. 70 W., Secs. 27 and 34.

[b]The North Well Field is in T. 35 N., R. 71 W., Secs. 13, 14, 15, 22-27, 34-36; T. 34 N., R. 71 W., Secs. 1-3, 10-15, 22-27; T. 34 N., R. 70 W., Secs. 18, 19; T. 35 N., R. 70 W., Secs. 7, 17-20, 28-32.

TABLE 2.6-17

WATER QUALITY IN WATER WELLS NEAR PACIFICORP'S PLANT SITE[a] AND NEARBY WELL FIELD[b]

Location		Aquifer	Well Depth	Sample Date	Ca	Mg	Na	K	HCO$_3$	SO$_4$	Cl	F	NO$_3$(N)	SiO$_2$	TDS (calculated)	pH
T. 34 N., R. 69 W., Sec. 1DAA	about 6 miles east of plant site	Eva Dale Lake Basin	318	06-07-69	131	64	120	10	276	725	3.1	0.2	0	6.8	1,170	8.0	12.0
T. 34 N., R. 69 W., Sec. 7DAA	about 11 miles east of plant site	Eva Dale Lake Basin	130	06-09-69	34	24	224	10	330	315	1.9	0.2	40	7.8	1,030	7.7	12.0
T. 34 N., R. 69 W., Sec. 12DDA	about 14 miles east of plant site	Eva Dale Lake Basin	320	06-07-69	31	22	46	7.6	272	70	3.4	0.2	30	7.6	336	8.1	12.0
T. 34 N., R. 69 W., Sec. 34AA	about 11 miles east of plant site	Eva Dale Lake Basin	435	06-05-69	6.6	3.8	134	2.5	364	105	3.2	8.8	20	7.9	344	8.1	12.0
	about 8 miles east of well field	Eva Dale Lake Basin	350														
T. 34 N., R. 70 W., Sec. 8CCB	about 12 miles east of plant site	Wasatch	217	05-07-69	93	29	324	4.0	301	124	8.5	0.2	30	11	1,240	7.6	12.0
T. 34 N., R. 72 W., Sec. 8AC	about 8 miles east of well field	Wasatch	217	10-09-69	34	8.5	146	1.4	184	274	3.2	0.3	18	11	577	7.7	12.0
T. 34 N., R. 72 W., Sec. 27DA	about 7 miles east of well field	Wasatch	350	07-09-69	45	7.8	94	6.0	232	140	4.8	—	—	—	434	8.4	—
T. 34 N., R. 71 W., Sec. 27DA	about 12 miles east of well field	Wasatch	180	08-06-69	48	15	55	5.7	320	136	3.4	0.3	20	15	372	7.7	12.0
T. 33 N., R. 71 W., Sec. 33	well field east well	Lower-Ohio Creek	2,320	02-23-73	5	1	340	5	610	13	32				601	8.0	34.0

Source: Eckman 1971.

[a]The plant site is in T. 33 N., R. 70 W., Sec. 17 and 18.

[b]The Hatch Well Field is in T. 33 N., R. 71 W., Sec. 11, 14, 17, 23-27, 34-36; T. 34 N., R. 71 W., Sec. 2-3, 10-15, 22-27; T. 34 N., R. 70 W., Sec. 18, 19; T. 33 N., R. 70 W., Sec. 1, 12-28, 34-36.

fully developed and it is a potential source of water supply for large-scale energy development (USGS 1975a).

The Paleozoic aquifer system has been described in detail on a regional basis in several recent studies (Konikow 1976; Cooley, Naff, and Konikow 1980; WCC 1980). All of these studies have implied that the Paleozoic aquifer system on the flanks of the Laramie Mountains is poorly connected in a hydraulic sense to the Madison aquifer system in the Powder River Basin. The Paleozoic aquifer system on the flanks of the Laramie Mountains was not discussed in detail in any of the previous studies.

Geologic Setting. The major water-bearing units in the Paleozoic aquifer system in the vicinity of the South Well Field are the Paleozoic sandstones and carbonates of the Flathead, Madison, and Casper formations. These units outcrop at the South Well Field in a narrow sinuous band, at most only a few miles wide, that trends approximately east-west along the flanks of the Laramie Mountains.

The Madison Formation in the vicinity of the South Well Field is about 200 feet thick, and it thickens gradually toward the north. Here it is composed primarily of blue-gray, cherty, sandy, massive limestone and dolomite, with small interbeds of siltstone, chert, and sandstone. The carbonates are likely dense, with low primary porosity and permeability. Fracturing is common along interbeds and in the chert zones (Boner et al. 1976). The water yielding characteristics of the Madison Formation in the vicinity of the South Well Field are probably due to well-developed zones of secondary porosity and permeability. Paleokarst features are present in the upper part of the Madison Formation in this area (Huntoon and Richter 1981). The solution features are reported to be infilled with well-cemented breccias in the subsurface (Huntoon and Richter 1981). Boner et al. (1976) has described the secondary permeability characteristics of the

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Geologic Setting. The major water-bearing units in the Paleozoic aquifer system in the vicinity of the South Wall Field are the Paleozoic sandstones and carbonates of the Flathead, Madison, and Casper formations. These units outcrop at the South Wall Field in a narrow arcuate band, as most only a few miles wide, that trends approximately east-west along the flanks of the Laramie Mountains.

The Madison Formation in the vicinity of the South Wall Field is about 200 feet thick, and it thickens gradually toward the north. Here it is composed primarily of blue-gray, cherty, sandy, massive limestone and dolomite, with small interbeds of siltstone, chert, and sandstone. The carbonates are likely dense, with low primary porosity and permeability. Fracturing is common along interbeds and in the chert zones (Sonnr et al. 1976). The water yielding characteristics of the Madison Formation in the vicinity of the South Wall Field are probably due to well-developed zones of secondary porosity and permeability. Paleokarst features are present in the upper part of the Madison Formation in this area (Hanson and Kicher 1981). The solution features are reported to be infilled with well-cemented breccias in the subsurface (Hanson and Kicher 1981). Sonnr et al. (1976) has described the secondary permeability characteristics of the

Madison Formation in the outcrops exposed in the valleys of Cottonwood Creek, Little Box Elder Creek, and Box Elder Creek. Along Cottonwood Creek and Little Box Elder Creek, they reported that the limestones in the middle and upper units of the Madison Formation have extensive secondary permeability in the form of fist-sized and smaller solution openings, and that sinkholes are indicated along Cottonwood Creek by small depressions in the alluvium. The Madison Formation along Box Elder Creek was reported to have little secondary permeability (Boner et al. 1976). Mancini (1976) and Boner et al. (1976) described prominent secondary porosity and permeability characteristics in the Madison Formation outcrops all along the northern flanks of the Laramie Mountains; similar features have been noted in numerous other locations in the Madison Formation (Swenson 1968a, 1968b; Whitcomb et al. 1958; USGS 1975a; WCC 1980).

The Cambrian-aged Flathead Sandstone (referred to by Boner et al. [1976] as basal Madison Formation) consists predominantly of rounded quartz and feldspar pebbles in a matrix of quartz sand with interbeds of shale, siltstone, and clay stone, and a basal conglomerate ranging up to 5 feet thick. The sandstone is well-cemented and probably has little intergranular or primary permeability (Boner et al. 1976). Secondary permeability was reported by Boner et al. (1976) to be developed along bedding plains, and secondary permeability may be developed along fault zones. The Flathead sandstone is between 50 and 75 feet thick in the outcrop area south of the well field (Huntoon and Richter 1981), and is up to 400 feet thick to the northwest in Natrona County (Crist and Lowry 1972).

Overlying the Madison Formation is the Pennsylvanian- and Permian-aged Casper Formation, composed predominantly of fine- to medium-grained sandstone that is weakly cemented and friable, with interbedded limestones, dolomites, and shales. Primary porosity and permeability are probably fairly high in the Casper Formation.

Probable hydraulic connection between the Madison and Casper formations is reported by Boner et al. (1976) to be very good in most areas along the northern Laramie Mountains. The Casper Formation is about 800 feet thick at the South Well Field.

Stratigraphically above the Casper Formation is a 1,000- to 1,500-foot sequence of predominantly clastic sediments, mainly siltstones and claystones comprising the Goose-Egg, Spearfish, Sundance, and Morrison formations. The water-yielding characteristics of these sediments are poorly known. Overlying these sediments is a sequence of Cretaceous shales, up to 5,000 feet thick, and generally massive with a very low vertical permeabilty (WCC 1980). Overlying the Cretaceous shales are the Fox Hills, Lance, Fort Union, and Wasatch formations, which are important regional aquifers.

In the vicinity of the well field, the Oligocene-aged White River Formation is exposed at the surface. This formation consists of light-gray soft sandstone, white tuffaceous clay, siltstone, and arkosic sandstone. These deposits yield sufficient quantities of water for stock and domestic uses.

The South Well Field is in a structurally complex area at the southern end of the Powder River Basin and on the northern flanks of the Laramie Mountains. Many faults and folds have been mapped in the area; a large thrust fault may lie to the north of the well field, and the pre-Tertiary strata in the area dip steeply to the north. The structural geology of the well-field area has been mapped by Huntoon and Richter (1981), and the regional structural geology has been mapped by Zapp (1951) and Barlow and Haun (1977).

Hydrologic Setting. The potentiometric surface of the Paleozoic aquifer system in the Powder River Basin has recently been mapped by Miller and Strausz (1980) and by Swenson et al. (1976).

Probable hydraulic connection between the Madison and Casper formations is reported by Bonnr et al. (1976) to be very good in most areas along the northern Laramie Mountains. The Casper formation is about 800 feet thick at the South Wall Field.

Stratigraphically above the Casper formation is a 1,000- to 1,300-foot sequence of predominantly clastic sediments, mainly siltstones and claystones comprising the Goose-Egg, Spearfish, Sundance, and Morrison formations. The water-yielding characteristics of these sediments are poorly known. Overlying these sediments is a sequence of Cretaceous shales, up to 3,000 feet thick, and generally massive with a very low vertical permeability (WCC 1980). Overlying the Cretaceous shales are the Fox Hills, Lance, Fort Union, and Wasatch formations, which are important regional aquifers.

In the vicinity of the well field, the Oligocene-aged White River formation is exposed at the surface. This formation consists of light-gray soft sandstone, white tuffaceous clay, siltstone, and arkosic sandstone. These deposits yield sufficient quantities of water for stock and domestic uses.

The South Wall Field is in a structurally complex area at the southern end of the Powder River Basin and on the northern flanks of the Laramie Mountains. Many faults and folds have been mapped in the area: a large thrust fault may lie to the north of the well field, and the pre-Tertiary strata in the area dip steeply to the north. The structural geology of the well-field area has been mapped by Eustoon and Richter (1981), and the regional structural geology has been mapped by Zapp (1953) and Barlow and Dean (1977).

<u>Hydrologic Setting.</u> The potentiometric surface of the Paleozoic aquifer system in the Powder River Basin has recently been mapped by Miller and Strauss (1980) and by Swenson et al. (1976).

Figure 2.4-12 presents data of Miller and Straus. Potentiometric data are abundant for the area near the Black Hills, where there are many wells and springs, but data points are few outside of the Black Hills Uplift.

The potentiometric surface of the Paleozoic aquifer system in the vicinity of the South Well Field ranges from about 5,600 feet in outcrop areas; to less than 5,440 feet in outcrops along LaPrele Reservoir; to about 5,300 feet at the Douglas City Springs, at Green Valley well #1, and in the LaPrele Creek valley; to about 5,200 feet in the Box Elder Creek valley. The surface apparently dips steeply into the Powder River Basin just north of the well field. Very steep dips in the potentiometric surface are known to occur to the northwest, in the vicinity of the Salt Creek oil fields. All potentiometric data points for the Paleozoic aquifer system in the vicinity of the South Well Field are shown in Figure 2.4-12.

The potentiometric gradients in the Paleozoic aquifer system indicate that water recharges the aquifer system at the outcrop areas of the Flathead, Madison, and Casper formations along the northern flanks of the Laramie Mountains and flows toward discharge points in the creek valleys and toward the central part of the Powder River Basin. The sharp change in potentiometric gradients from the South Well Field area to the Powder River Basin suggests that little of the water that recharges the Paleozoic aquifer at the outcrop area flows into the basin, or that the transmissivity of the Paleozoic aquifer is relatively high in the Powder River Basin, or both.

The steep gradients probably imply that the north-south component of the transmissivity tensor in the zone of steeply dipping beds north of the well field is very low relative to the overall transmissivity in the Powder River Basin. This zone may correlate with offsets of

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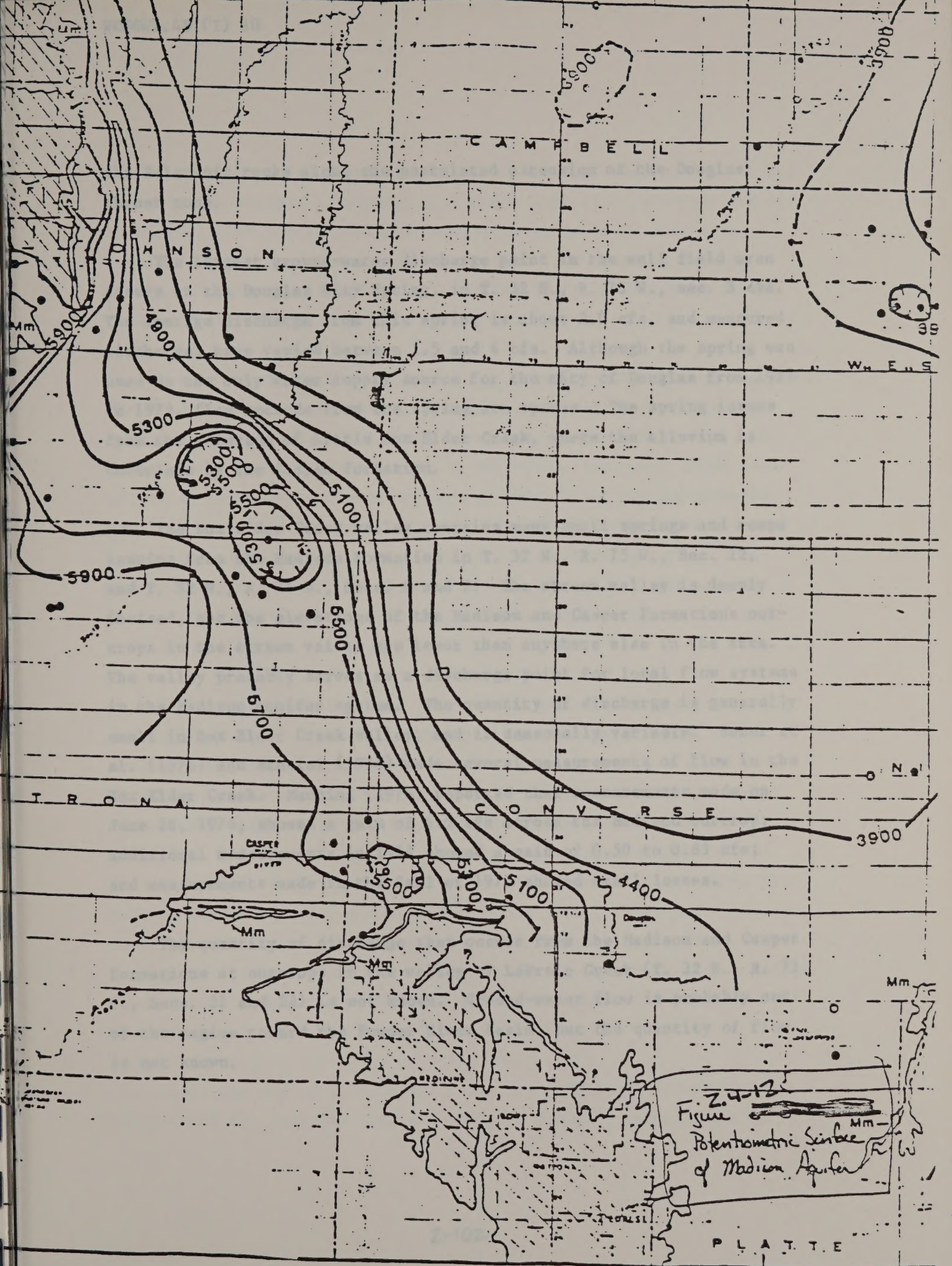


Source: Miller and Strauss 1980.

the Paleozoic rocks along the postulated extension of the Douglas thrust zone.

The largest ground-water discharge point in the well field area occurs at the Douglas City Spring, in T. 32 N., R. 73 W., sec. 3 dba. The average discharge from this spring is about 2.0 cfs, and measured discharges have varied between 1.5 and 4 cfs. Although the spring was used as the only water supply source for the city of Douglas from 1923 to 1979, flow records from the spring are sparse. The spring issues from the alluvium of Little Box Elder Creek, where the alluvium is underlain by the Casper Formation.

The Box Elder Creek valley contains many small springs and seeps issuing from the Madison Formation in T. 32 N., R. 75 W., Sec. 12, and T. 32 N., R. 74 W., Secs. 6 and 7. The stream valley is deeply incised, and the elevations of the Madison and Casper Formations outcrops in the stream valley are lower than anywhere else in the area. The valley probably serves as a discharge point for local flow systems in the Madison aquifer system. The quantity of discharge is generally small in Box Elder Creek valley, and is seasonally variable. Boner et al. (1976) and Mancini (1976) made several measurements of flow in the Box Elder Creek. Mancini (1976) reported that measurements made on June 26, 1974, showed a gain of 6.5 cfs across the Madison outcrop; additional measurements in 1974 showed a gain of 0.50 to 0.83 cfs; and measurements made in the fall of 1975 showed small losses.

The quantity of discharge that occurs from the Madison and Casper formations at outcrops in the valley of LaPrele Creek (T. 32 N., R. 73 W., Secs. 21 and 22) is not known. Ground-water flow is probably out of the region toward the Powder River Basin, but the quantity of flow is not known.

the Paleozoic rocks along the postulated extension of the Douglas thrust zone.

The largest ground-water discharge point in the well field area occurs at the Douglas City Spring, in T. 32 N., R. 73 W., sec. 3 cbd. The average discharge from this spring is about 2.0 cfs, and measured discharges have varied between 1.5 and 4 cfs. Although the spring was used as the only water supply source for the city of Douglas from 1923 to 1979, flow records from the spring are sparse. The spring issues from the alluvium of Little Box Elder Creek, where the alluvium is underlain by the Casper Formation.

The Box Elder Creek valley contains many small springs and seeps issuing from the Madison Formation in T. 32 N., R. 73 W., Sec. 12, and T. 32 N., R. 74 W., Secs. 5 and 7. The stream valley is deeply incised, and the elevations of the Madison and Casper Formations outcrops in the stream valley are lower than anywhere else in the area. The valley probably serves as a discharge point for local flow systems in the Madison aquifer system. The quantity of discharge is generally small in Box Elder Creek valley, and is inconsequentially variable. Hood et al. (1974) and Mandel (1975) made several measurements of flow in the Box Elder Creek. Mandel (1975) reported that measurements made on June 26, 1974, showed a gain of 5.5 cfs across the Madison outcrop; additional measurements in 1974 showed a gain of 0.50 to 0.67 cfs; and measurements made in the fall of 1975 showed small losses.

The quantity of discharge that occurs from the Madison and Casper Formations as outcrops in the valley of Laramie Creek (T. 32 N., R. 73 W., Secs. 31 and 32) is not known. Ground-water flow is probably out of the region toward the Powder River Basin, but the quantity of flow is not known.

The Paleozoic aquifer system in this area is recharged by streams crossing the Flathead, Madison, and Casper formation outcrops, and by infiltration of precipitation. Most recharge probably occurs where Little Box Elder and Cottonwood creeks lose flow crossing Madison Formation outcrops. The Paleozoic aquifer system may also be recharged by LaPrele Reservoir.

Little Box Elder Creek, which is a perennial stream above the Flathead and Madison formation outcrops, loses all of its flow when crossing the Flathead and Madison Formation outcrops in T. 32 N., R. 74 W., Secs. 8 and 9, during most of the year. The creek flows downstream of the Madison formation outcrop only during spring snowmelt and following large precipitation events. The U.S. Geological Survey maintained gaging stations on Little Box Elder Creek at the Precambrian-Flathead contact (T. 32 N., R. 74 W., Sec. 9bda) during water years 1975 to 1979; average stream flow loss during this period was 1.07 cfs.

Cottonwood Creek has been reported by Huntoon and Richter (1981) and by Boner et al. (1976) to gradually lose all of its flow when crossing the Flathead and Madison formation outcrops in T. 32 N., R. 74 W., Secs. 13 and 14. On the basis of sporadic flow measurements, Huntoon and Richter (1981) estimated an average flow loss of about 0.75 cfs. Boner et al. (1976) measured a flow loss of 0.64 cfs on July 30, 1974. The annual average flow of Cottonwood Creek above the Madison Formation outcrop during the period 1974 to 1979 was estimated to be about 0.5 cfs, based on the ratio of drainage basin areas in the Cottonwood Creek and Little Box Elder Creek basin. Therefore, average annual flow losses at the Flathead and Madison formation outcrops are probably less than 0.5 cfs.

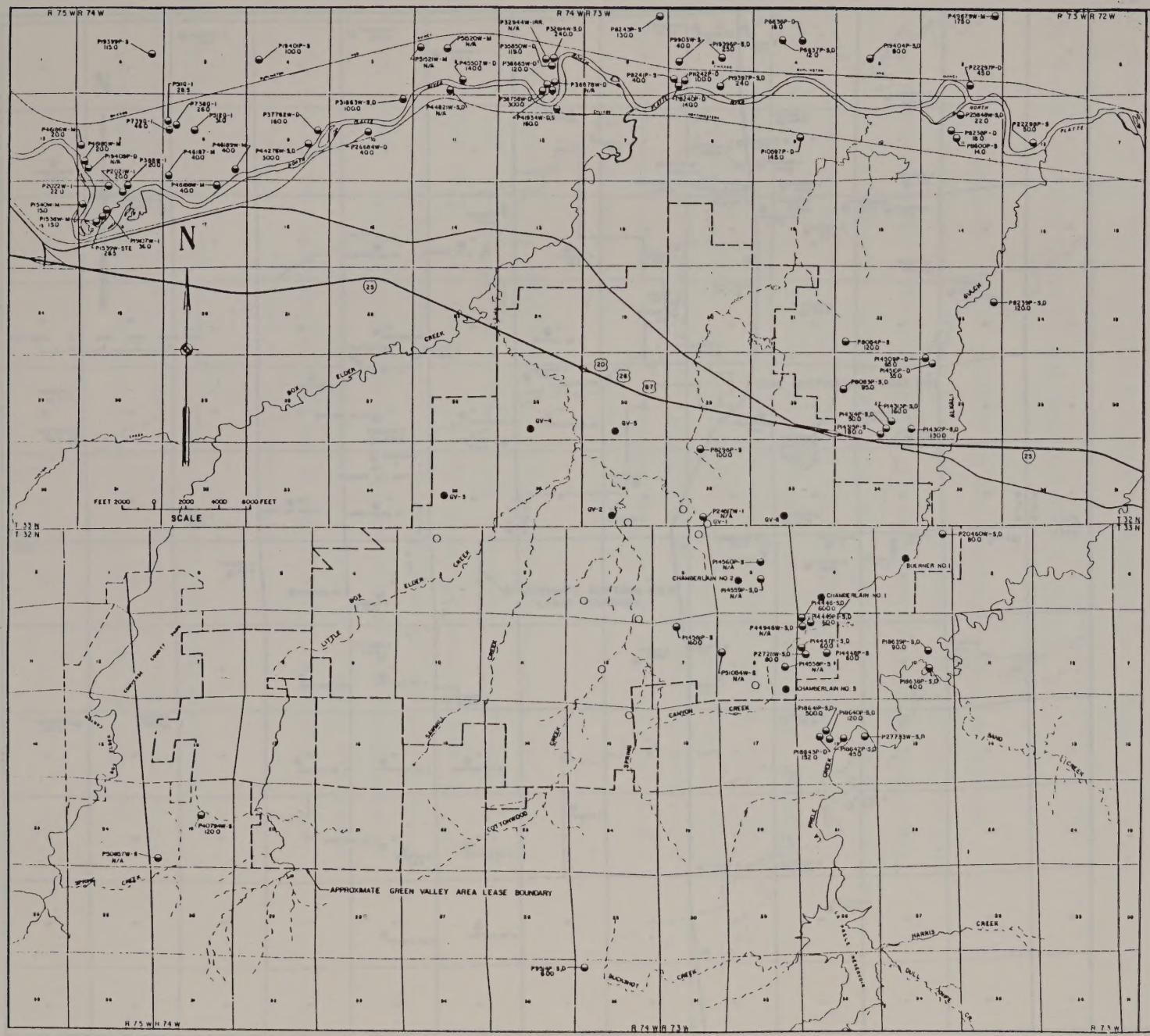
The lower end of LaPrele Reservoir and LaPrele Dam rests on outcrops of the Casper Formation. Seepage probably occurs from the

reservoir but the quantities of seepage are unknown. This recharge probably discharges below the dam, where the Casper Formation is exposed along the creek for more than a mile.

The recharge that occurs to the Flathead, Madison, and Casper formation outcrops in the area by direct infiltration of precipitation can only be roughly estimated. Mancini (1976) developed an empirical relationship for the difference between precipitation and evapotranspiration as a function of elevation along the northern flank of the Laramie Mountains; the calculated difference was about 2.8 inches in the Flathead, Madison, and Casper formation outcrop areas in the South Well Field area. This is an upper limit on potential recharge, as some surface runoff occurs. Huntoon and Lundy (1979) calculated recharge to the Casper Formation near Laramie, Wyoming, where the Casper Formation is lithologically similar and the climate is similar to that in the South Well Field area. They calculated a recharge rate of 1.4 inches, about 10 percent of average annual recharge, based on known discharge rates and the known outcrop area.

Water Use. The city of Douglas is the largest user of water from the Madison aquifer system near the South Well Field. The city has been using the Douglas City Springs as a municipal water supply since 1923, when a spring house was constructed to collect all the discharge from the spring, and a pipeline was laid to the city. Present spring discharge is estimated at 2 to 3 cfs (Glass 1981).

A few water wells are completed in the Paleozoioc aquifer system north of the flanks of the Laramie Mountains (Figure 2.4-13). Only two unused wells are completed in the Madison System within a two-mile radius of the well field: the U.S. Geological Survey's observation well at the Barber Ranch (T. 32 N., R. 74 W., Sec. 32), and an abandoned oil well (T. 33 N., R. 74 W., Sec. 3). Only one well open to the Casper Formation in Ayres Natural Bridge Park along LaPrele Creek,



LEGEND

○ REVISED WELL LOCATIONS AS PROPOSED

● WELL LOCATIONS AS APPLIED FOR

P27330W-S 198.0 ◒ WELL LOCATIONS WITH GROUNDWATER PERMITS. UPPER NUMBER INDICATES PERMIT NUMBER AND USE. LOWER NUMBER INDICATES DEPTH OF WELL. N/A INDICATES DEPTH UNKNOWN.

USE KEY

S = Stock
D = Domestic
I = Industrial
IRR = Irrigation
M = Miscellaneous
STE = Steam Generation

FIGURE 2.4-13a

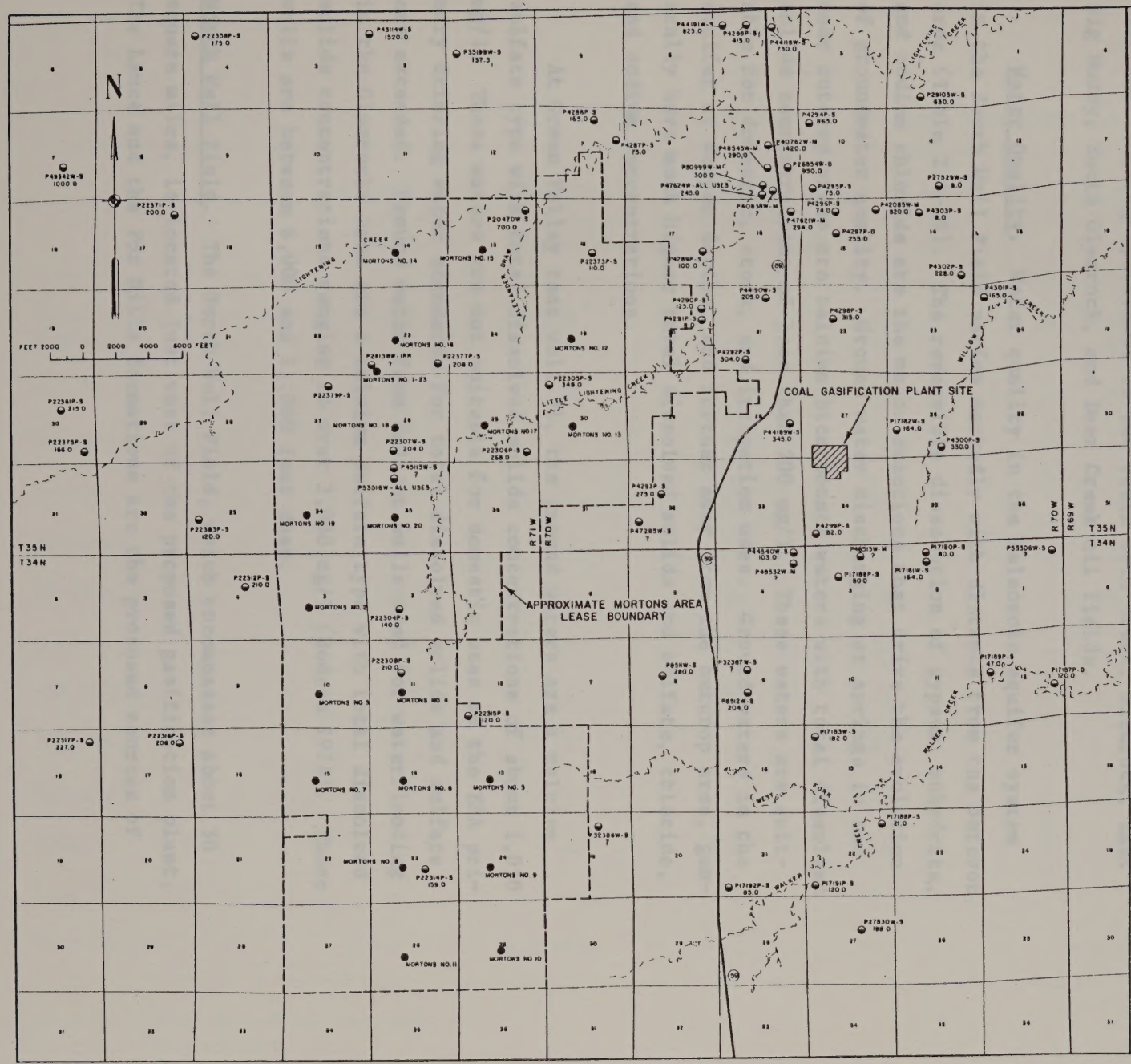
BANNER ASSOCIATES, INC.
CONSULTING ENGINEERS & ARCHITECTS
150 PLAZA CT. LARAMIE, WYOMING

WyCoalGas Projects

PERMITTED

WELL LOCATION MAP
GREEN VALLEY AREA

DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO	
TLV	PWH	3-81	SHOWN	1803-1	FIGURE I-2



LEGEND

● WELL LOCATIONS AS APPLIED FOR

P27530W-S 198.0 WELL LOCATIONS WITH GROUNDWATER PERMIT. UPPER NUMBER INDICATES PERMIT NUMBER AND USE. LOWER NUMBER INDICATES DEPTH OF WELL. ? INDICATES DEPTH UNKNOWN.

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FIGURE 2.4-13b

BANNER ASSOCIATES INC.

WyCoalGas Projects

PERMITTED

WELL LOCATION MAP
MORTONS AREA

DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	
DAM	PWH	3-81	SHOWN	1803-1	FIGURE I-1

2-106

is known to exist within a two-mile radius of the well field. All other known wells are completed in the Lance-Fox Hills, Wasatch, Fort Union, Arikaree, and White River formations.

Seven wells completed in the Madison formation are located about 20 miles west of the well field in the Glenrock area. These wells are used for flooding operations in the South Cole Creek, Glenrock, East Big Muddy, South Glenrock, and Deer Creek oil fields.

Water Quality. Water quality in the Paleozoic aquifer system in the South Well Field varies markedly with distance from the outcrop area (Table 2.4-18). The reversible dissolution of gypsum, anhydrite, and sodium chloride are the major reactions that drive the evolution of groundwater quality. Ground water discharging at springs in and near outcrop areas are calcium bicarbonate waters with total dissolved solids concentrations of less than 200 mg/l. These waters are suitable for domestic, stock, and irrigation uses. Ground waters in the aquifer at deeper depths, and further away from the outcrop area, generally have much higher total dissolved solids and sulfate, chloride, and sodium concentrations.

At Green Valley test well #1, the ground waters are a calcium sulfate type with total dissolved solids concentrations of about 1,050 mg/l. These waters are not suitable for domestic uses as the EPA primary drinking water standards for total dissolved solids and sulfate are exceeded. Ground water from Madison wells used for waterflooding in the Glenrocks area are a calcium sulfate type with total dissolved solids concentrations ranging to over 3,000 mg/l (Hodson 1974). These wells are between 6,000 and 11,000 feet deep.

North Well Field. The North Well Field, which encompasses about 30 square miles, is located just west of the proposed gasification plant. The Lance and the Fox Hills formations are the proposed sources of

TABLE 2.4-18

GROUND WATER QUALITY IN THE SOUTH WELL FIELD AREA

	Green Valley[a] Well # 1 33-73-32	Douglas[a] City Spring 32-74-3db	Continental Oil Company[b] Madison Water Flood Wells 33-75-20aac	33-75-8dbb	Flathead Springs[a] on Little Box Elder Cr. 32-74-17ba	Flathead Springs[a] on Cottonwood Cr. 32-74-23cb
Total Dissolved Solids	1,052	150	1,010	2,970	110	102
Total Hardness ($CaCO_3$)	—	230	514	1,230	160	110
Calcium	154	54	156	355	38	34
Magnesium	33	22	30	82	16	6.6
Sodium	129	11	103	488	.6	7
Potassium	26	2	12	37	.8	1.7
Bicarbonate	195	240	124	95	200	140
Sulfate	520	35	512	1,370	3.3	6.6
Chloride	94	4	100	556	.7	1.1
Fluoride	—	.7	1.4	4.0	1.2	.6
Nitrate	—	3.7	.2	0.0	5	2.4
Boron	—	.01	110	710	.01	.02
Iron	—	—	—	—	—	—
Date Sampled	5/14/74	12/29/80	7/72	7/72	12/29/80	12/30/80

Sources: [a]Huntoon and Richter 1981.
[b]Hodson 1974.

TABLE 2.4-12

GROUND WATER QUALITY IN THE SOUTH WEST, FIELD AREA

	Green Valley[a] Well # 1 33-23-32	Douglas[a] City Spring 33-24-34b	Continental Oil Company[b] Medicom Water Flood Wells 33-23-20aac	33-24-6bbb	Flathead Springs[c] on Little Box Elder Cr. 33-23-17ba	Flathead Springs[c] on Cottonwood Cr. 33-24-23cb
Total Dissolved Solids	1,047	150	1,010	2,970	110	102
Total Hardness ($CaCO_3$)	—	290	314	1,230	140	110
Calcium	154	54	136	155	38	34
Magnesium	23	22	30	83	16	8.6
Sodium	125	11	100	422	6	7
Potassium	26	2	12	37	.8	1.7
Bicarbonate	195	240	124	83	200	140
Sulfate	530	55	372	1,210	1.3	8.8
Chloride	34	4	420	334	.2	1.1
Fluoride	—	.7	1.4	4.0	1.2	.6
Nitrate	—	1.7	.2	0.2	5	2.4
Boron	—	.41	115	710	.01	.02
Iron	—	—	—	—	—	—
Date Sampled	5/14/74	12/29/80	7/72	7/72	12/29/80	12/29/80

Sources: [a]Hamilton and Bichum 1981.
[b]Bichum 1974.

ground water at this well field. These formations consist of about 3,500 feet of interbedded sandstones, siltstones, and claystones that occur between about 3,000 and 6,500 feet below land surface. The Fort Union and Wasatch formations, which are lithologically similar to the Lance Formation and have a combined thickness of over 3,000 feet, overlie the Lance Formation. The Fox Hills Formation is underlain by a 5,000- to 6,000-foot sequence of Cretaceous shales.

The Lance and Fox Hills formations outcrop along the margins of the Powder River Basin in Wyoming, and are continuous in the subsurface in the Powder River Basin. These formations are important aquifers in the outcrop areas, where they are tapped extensively for stock and domestic water, but in areas where the formations do not outcrop, they are tapped by only a few wells for municipal uses and for oil field water-flooding operations. The formations are not important aquifers in the central part of the Powder River Basin because of their depth, the small water yields typically obtained, and the generally poor water quality in the formation. The Wasatch and Fort Union formations are the sources of water for stock and domestic purposes in the vicinity of the North Well Field.

Ground-Water Movement. The potentiometric surface of the Lance-Fox Hills aquifer system in the southern part of the Powder River Basin is poorly defined because of limited data (Figure 2.4-14). The available data suggest that water recharges the aquifer system in outcrop areas along the southwestern margins of the Powder River Basin and flows northeast, discharging at the outcrop areas in Niobrara County. Potentiometric gradients between the outcrop area and the North Well Field average only about 28 feet per mile. Total ground-water flow in the system is not large. Based on an average hydraulic conductivity of 0.25 gallons per day per square foot and a porosity of 0.15, flow in the aquifer system in the vicinity of the well field is about 0.03 cfs per mile width of the aquifer normal to

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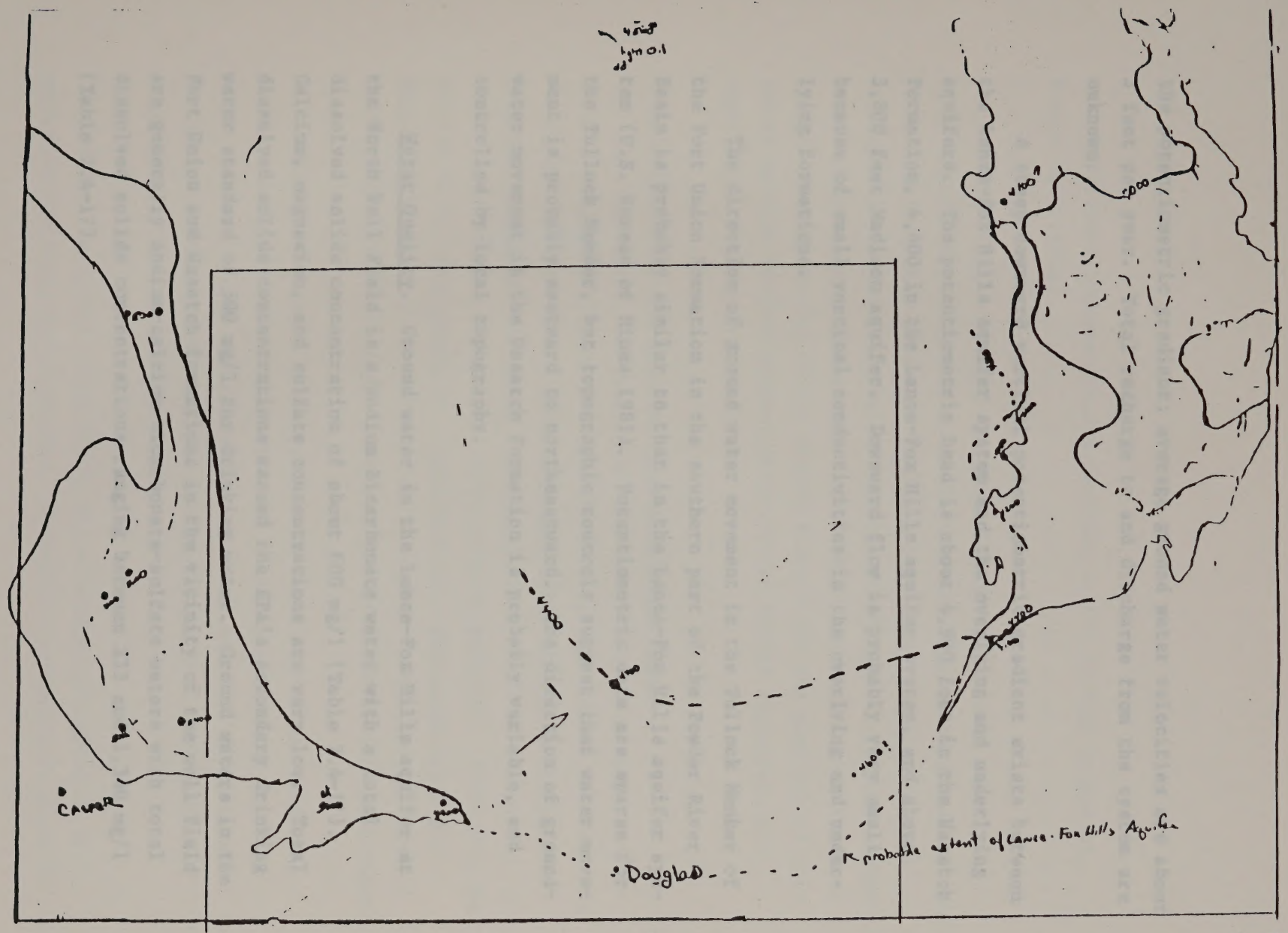

Figure 2.4-14 Schematic of the Potentiometric Surface in Lance - Fox Hills Aquifers

the potentiometric gradient; average ground water velocities are about 3 feet per year. Total recharge to and discharge from the system are unknown.

A steep downward vertical potentiometric gradient exists between the Lance-Fox Hills aquifer system and the overlying and underlying aquifers. The potentiometric head is about 4,900 feet in the Wasatch Formation, 4,400 in the Lance-Fox Hills aquifer system, and about 3,800 feet Madison aquifer. Downward flow is probably very small because of small vertical conductivities in the overlying and underlying formations.

The direction of ground water movement in the Tullock Member of the Fort Union Formation in the southern part of the Powder River Basin is probably similar to that in the Lance-Fox Hills aquifer system (U.S. Bureau of Mines 1981). Potentiometric data are sparse for the Tullock Member, but topographic controls suggest that water movement is probably eastward to northeastward. The direction of groundwater movement in the Wasatch Formation is probably variable, and controlled by local topography.

Water Quality. Ground water in the Lance-Fox Hills aquifer at the North Well Field is a sodium bicarbonate water with a total dissolved solids concentration of about 600 mg/l (Table 2.4-17). Calcium, magnesium, and sulfate concentrations are very low. Total dissolved solids concentrations exceed the EPA's secondary drinking water standard of 500 mg/l for drinking water. Ground waters in the Fort Union and Wasatch formations in the vicinity of the well field are generally sodium-calcium-bicarbonate-sulfate waters with total dissolved solids concentrations ranging between 235 and 1,340 mg/l (Table 2.4-17).

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2.5 VEGETATION

Additional information can be found in the Biology Technical Report (WCC 1981d).

Kuchler (1966) divided the general area which would contain project components into two potential natural vegetation zones. North of the North Platte River the project would occupy Kuchler's grama-needlegrass-wheatgrass grassland; south of this point it would occupy a grama-buffalograss grassland. Dorn (1977) referred to the flora of eastern Wyoming as the "Great Plains Flora." For the purposes of this report we have further divided Dorn's Great Plains Flora into the vegetation types described below.

Prairie Grassland and Prairie Grassland-Breaks Types

This type is a combination of the shortgrass and mixed prairie natural vegetation types described by Dorn (1977). Areas dominated by shortgrass species (i.e., Buchloe dactyloides, Bouteloua gracilis, Koeleria macrantha, and Carex filifolia) are typical of flatter plains that receive moderate to heavy grazing pressure. Mixed prairie species (i.e., Andropogon sp., Agropyron sp., Bouteloua curtipendula, and Stipa sp.) occur in areas of rougher topography, and generally exist in the "mixed" state as a result of lower grazing pressure.

For the most part, these grasslands occur on shallow clayey, shallow sandy, and shallow loamy range sites, all of which usually occur on steep slopes and ridge tops, but may occur on all slopes in the 10 to 14-inch Northern Plains precipitation zone (U.S. Soil Conservation Service 1977).

In shallow clayey range sites, the climax plant community is typically dominated by midgrasses. Potential vegetation is about 80

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Prairie Grassland and Prairie Grassland-Brushy Types

This type is a combination of the shortgrass and mixed prairie natural vegetation types described by Born (1977). Areas dominated by shortgrass species (i.e., Buchloe dactyloides, Bouteloua gracilis, Koeleria macrantha, and Carex filifolia) are typical of flatter plains that receive moderate to heavy grazing pressure. Mixed prairie species (i.e., Andropogon sp., Aristida sp., Bouteloua curtipendula, and Stipa sp.) occur in areas of rougher topography, and generally exist in the "mixed" state as a result of lower grazing pressure.

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In shallow clayey range sites, the climax plant community is typically dominated by midgrasses. Potential vegetation is about 80

percent grasses and grass-like species, 10 percent forbs, and 10 percent woody plants. Approximate ground cover is 15 to 25 percent, and as range conditions deteriorate, big sagebrush and birds foot sagebrush become more dominant. Broom snakeweed and annuals are typical invaders (U.S. Soil Conservation Service 1977). Total annual production during favorable years is approximately 1,200 lbs/acre, 900 lbs/acre during median years, and 450 lbs/acre during unfavorable years. These sites usually provide good forage for cattle, sheep, horses, and wildlife yearlong. The Soil Conservation Service's suggested stocking rates on these sites range from 0.2 Animal Unit Months (AUMs)/acre on ranges in excellent condition to 0.05 AUMs/acre on ranges in poor condition in the 10 to 14-inch Northern Plains precipitation zone.

On shallow sandy range sites the climax plant community is typically dominated by tall and midgrasses with potential vegetation being comprised of 70 percent grass and grass-like plants, 15 percent forbs, and 15 percent woody plants. Approximate ground cover ranges from 15 to 25 percent, and as range conditions deteriorate, threadleaf sedge and fringed sagewort become more prevalent. Typical invaders include broom snakeweed and annuals. Total annual production in favorable years is approximately 1,400 lb/acre, in median years roughly 1,000 lb/acre, and in unfavorable years 600 lb/acre (U.S. Soil Conservation Service 1977). These sites provide good year-round forage for cattle, sheep, wildlife, and horses. The Soil Conservation Service's recommended initial stocking rate ranges from 0.2 AUMs/acre for ranges in excellent condition to 0.05 AUMs/acre in poor sites.

In shallow loamy range sites the climax plant community is dominated by midgrasses, and potential natural vegetation is typically about 80 percent grasses and grass-like species, 10 percent forbs, and 10 percent woody plants. The approximate ground cover on these range sites is 15 to 25 percent, and as range condition deteriorates, blue

grama and threadleaf sedge become more dominant. Typical invaders of deteriorated shallow loamy range sites include broom snakeweed, cactus, and annuals (U.S. Soil Conservation Service 1977). Total annual production in favorable years is approximately 1,200 lb/acre; in median and unfavorable years the figures are 900 and 450 lb/acre, respectively. These sites provide good year-round forage for cattle, sheep, wildlife, and horses. Suggested initial stocking rates are 0.2 AUMs/acre on ranges in excellent condition, 0.17 AUMs/acre on good sites, 0.10 AUMs/acre on fair sites, and 0.05 AUMs/acre on poor sites.

Open Ponderosa Pine Forest, Open Ponderosa Pine Forest-Breaks, and Ponderosa Pine Forest Types

Each of these vegetation types is a variation, dependent on degree of canopy cover, of Dorn's (1977) ponderosa pine type. Typically, they occur on lower mountain slopes, foothills, and water-trapping rock formations in the plains. Representative species include *Pinus ponderosa* and *Arctostaphylos uva-ursi*. Ponderosa pine and rocky mountain juniper dominate the overstory. The understory typically contains mountain mahogany, fringed sagewort, skunkbush, rose, blazing star, wild buckwheat, wheatgrasses, little bluestem, threeawn, sideoats grama, blue grama, prairie junegrass, and squirrel tail. In areas with a more open canopy, the understory grassland is similar to Dorn's mixed prairie grassland type, previously described.

Dry Stream Bottom Type

Because they are intermittent, most of the streams that would be traversed lack sufficient water to support a cottonwood riparian community. However, isolated willows are sometimes found. The dry stream bottom type includes those stream crossings that show little similarity to the surrounding vegetation type. Stream-bank vegetation

grass and threadleaf sedge become more dominant. Typical invaders of deteriorated shallow loamy range sites include broom snakeweed, cactus, and annuals (U.S. Soil Conservation Service 1977). Total annual production in favorable years is approximately 1,200 lb/acre; in median and unfavorable years the figures are 900 and 450 lb/acre, respectively. These sites provide good year-round forage for cattle, sheep, wildlife, and horses. Suggested initial stocking rates are 0.2 AUMs/acre on ranges in excellent condition, 0.17 AUMs/acre on good sites, 0.10 AUMs/acre on fair sites, and 0.05 AUMs/acre on poor sites.

Open Pondeross Pine Forest, Open Pondeross Pine Forest-Grass, and Pondeross Pine Forest Types

Each of these vegetation types is a variation, dependent on degree of canopy cover, of Dorn's (1977) pondeross pine type. Typically, they occur on lower mountain slopes, foothills, and water-trapping rock formations in the plains. Representative species include Pinus ponderosa and Arctostaphylos uva-ursi. Pondeross pine and rocky mountain juniper dominate the overstory. The understory typically contains mountain mahogany, fringed sagewort, skunkbush, rose, blazing star, wild buckwheat, wheatgrasses, little bluestem, threeawn, sideoats grama, blue grama, prairie junegrass, and squirrel tail. In areas with a more open canopy, the understory grassland is similar to Dorn's mixed prairie grassland type, previously described.

Dry Stream Bottom Type

Because they are intermittent, most of the streams that would be traversed lack sufficient water to support a cottonwood riparian community. However, isolated willows are sometimes found. The dry stream bottom type includes those stream sections that show little similarity to the surrounding vegetation type. Stream-bank vegetation

generally includes willows, horsetail, bulrush, and slender wheatgrass, with alkali sacaton and black greasewood occurring on more alkaline sites. In more rocky areas, ponderosa pine occurs near the stream banks. Along more sandy stream banks, wild licorice, two-grooved milkvetch, broom snakeweed, spreading wild buckwheat, fringed sagewort, Indian ricegrass, and snowball sand verbena are common (Ecology Consultants, Inc. 1975).

Plains Cottonwood Type

This is a combination of Dorn's plains cottonwood and box elder-elm-ash types. Representaative species include *Populus deltoides*, *Shepherdia argentea*, *Acer negundo*, *Ulmus americana*, and *Fraxinus pennsylvanica*. Ecology Consultants, Inc. (1975) divided the North Platte River cottonwood riparian zone into two subtypes: a rush/bulrush community (*Juncus torreyi*/*Scirpus acutus*) that typically occupies wet areas adjacent to the river, and a dry stream bank community dominated by perennial grasses and large cottonwoods. The understory is typically dominated by species such as alkali sacaton, western wheatgrass, alkali cordgrass, and bulrush. Common weedy forbs include oakleaf, goosefoot, and bushy knotweed.

Scoria Type

The scoria vegetation type occupies moderate to steep slopes where exposed coal seams burned, resulting in reddish, rocky soil (Econ, Inc. 1980a). Scoria covers nearly 21 percent of the site. Dominant grass species include blue grama, needle-and-thread, threadleaf sedge (*Carex filifolia*), and bluebunch wheatgrass. Dominant forbs, (high cover or high frequency) are fringed sagewort, Hood's phlox, silverleaf scurfpea (*Psoralea argophylla*), and scarlet globemallow. Big sagebrush and plains pricklypear are dominant shrubs. Range conditions are fair, and permit areas typically produce 402 lbs/acre annually (Econ, Inc. 1980a). Carrying capacity is 0.05

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Plains Cottonwood Type

This is a combination of Dora's plains cottonwood and box elder-ash-ash type. Representative species include Populus deltoides, Rhamnus alnifolia, Acer negundo, Fraxinus americana, and Fraxinus pennsylvanica. Ecology Consultants, Inc. (1975) divided the North Platte River cottonwood riparian zone into two subtypes: a tall bulrush community (Juncus torreyi/Scirpus atrocinctus) that typically occupies wet areas adjacent to the river, and a dry stream bank community dominated by perennial grasses and large cottonwoods. The understory is typically dominated by species such as alkali saccaton, western wheatgrass, alkali cordgrass, and bulrush. Common weedy forbs include cocklebur, goosefoot, and bushy knotweed.

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AUMs/acre, and consequently 67 total AUMs exist in this type on the proposed mine site.

Agricultural Lands

This type consists of plowed areas which may or may not be currently cultivated. Some of the agricultural lands which would be affected appear to be abandoned. Abandoned croplands are generally dominated by weedy species such as red threeawn, Russian thistle, and yellow salisfy. Older abandoned fields often resemble the original communities with needle-and-thread, blue grama, western wheatgrass, and big sagebrush being typical invaders.

Urban and Built-up Lands

This category includes any areas, including transportation corridors, which have been previously disturbed by construction activities.

Threatened or Endangered Species

There are no federally listed or "officially" proposed threatened or endangered plant taxa in the vicinity of proposed project components (Federal Register 45(242):82480-82569). However, two plant taxa (Rorippa calycina and Guara neomexicana ssp. coloradensis), which are currently under review for inclusion in the federal list, could occur in the vicinity of the project component sites.

Rorippa calycina (persistent sepal yellowcress) is currently under review for possible listing by the U.S. Fish and Wildlife Service as federally endangered or threatened (Federal Register 45(242):December 15, 1980). Dorn (1980) lists the present Wyoming distribution as "Carbon County, Wyoming, from Seminoe Reservoir to Medicine Bow." Habitat for this species is sandy river or reservoir shoreline near the high water mark (Dorn 1980). Bob Lichvar (Wyoming Nature Conservancy~~, personal communication, January 8,~~ 1981) has

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Urban and Built-up Lands

This category includes any areas, including transportation corridors, which have been previously disturbed by construction activities.

Threatened or Endangered Species

There are no federally listed or "officially" proposed threatened or endangered plant taxa in the vicinity of proposed project components (Federal Register 45(242):82580-82582). However, two plant taxa (*Astragalus calycina* and *Cuscuta pacomyiensis* ssp. *colorado*), which are currently under review for inclusion in the Federal list, could occur in the vicinity of the project component sites.

Astragalus calycina (perennial sagebrush) is currently under review for possible listing by the U.S. Fish and Wildlife Service as federally endangered or threatened (Federal Register 45(242):December 15, 1980). Dorn (1980) lists the present Wyoming distribution as "Carbon County, Wyoming, from Seminoe Reservoir to Medicine Bow." Habitat for this species is sandy river or reservoir shorelines near the high water mark (Dorn 1980). Bob Lichvar (Wyoming Nature Conservancy, personal communication, January 5, 1981) has

suggested that this species may have been transported east through the North Platte River system. Consequently, Rorippa calycina could exist at the proposed product pipeline crossing of the North Platte River downstream of Guernsey Reservoir, at the proposed North Platte intake location, at the confluence of LaPrele Creek with the North Platte River, and at the proposed South Well Field to the plant site water line crossing of the North Platte River near Douglas.

Gaura neomexicana ssp. coloradensis (Colorado butterfly-weed) is currently under review by the U.S. Fish and Wildlife Service for potential listing as federally endangered or threatened (Federal Register 45(242):December 15, 1980). Dorn (1980) lists the present distribution as "Weld County, Colorado and Laramie County, Wyoming, near Cheyenne." Ecology Consultants, Inc. (1978) lists humic soils in wet areas and drainage bottoms at elevations of 5,000 to 6,000 feet as habitat for Gaura neomexicana ssp. coloradensis. Dorn (1980) adds that moist meadows at transitions between wet stream bottoms and dry uplands comprise typical habitat for this subspecies.

The potential for occurrence of the Colorado butterfly-weed exists in any wet meadow habitat on the southern end of the proposed product pipeline corridor (Lichvar, Wyoming Nature Conservancy, personal communication, January 8, 1981; Dorn, Wyoming Department of Environmental Quality, personal communication, December 15, 1980).

At the present time, Wyoming lacks state-level endangered species legislation. Although Colorado has a State Endangered Species Act, no plant species are listed.

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Euera neomexicana ssp. coloradensis (Colorado butterfly-weed) is currently under review by the U.S. Fish and Wildlife Service for potential listing as federally endangered or threatened (Federal Register 45(241):December 15, 1980). Dorn (1980) lists the present distribution as "Weld County, Colorado and Laramie County, Wyoming, near Cheyenne." Ecology Consultants, Inc. (1978) lists moist soils in wet areas and drainage bottoms at elevations of 5,000 to 6,000 feet as habitat for Euera neomexicana ssp. coloradensis. Dorn (1980) adds that moist meadows at transitions between wet areas bottoms and dry uplands comprise typical habitat for this subspecies.

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At the present time, Wyoming lacks state-level endangered species legislation. Although Colorado has a State Endangered Species Act, no plant species are listed.

2.6 WILDLIFE

Terrestrial wildlife species occupying habitats that would be disturbed or eliminated by the proposed action or alternatives are discussed in detail in the Biology Technical Report (WCC 1981d). Table 2.6-1 lists the general occurrence of important wildlife species and groups by vegetation habitat type. Acreages which would be permanently and temporarily disturbed in each type are summarized in Table 3.4-1. Species of high interest and their proximity to proposed project components are briefly described below.

Big Game

Mule deer, pronghorn antelope, and white-tailed deer are the principal big game species that occur at proposed project components. Elk could occur rarely in the vicinity of the proposed mine site (Econ, Inc. 1980b). Mule deer and antelope are ubiquitous in the entire project area while the range of the white-tailed deer is restricted to riparian vegetation which would be affected by the product pipeline, the South Well Field, the pipeline from the South Well Field to the plant site, the North Platte intake, and the railroad.

Mule deer could occur in most vegetation types affected by proposed project components (Table 2.6-1). All of the areas that would be disturbed and that are presently occupied by mule deer provide year-long habitat, and no critical habitat would be affected (Wyoming Game and Fish Department 1980). Riparian (plains cottonwood type) and other drainage-related habitat concentrates mule deer in eastern Wyoming during winter, especially during periods of heavy snow. The proposed railroad corridor would traverse one such area, the Porcupine Creek basin, which is of particular importance to mule deer (Wyoming Game and Fish Department 1981). No other areas of known importance

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TABLE 2.6-1

OCCURRENCE OF IMPORTANT WILDLIFE SPECIES IN VEGETATION HABITAT TYPES WHICH WOULD BE DISTURBED BY PROJECT COMPONENTS

	Prairie Grassland Type	Ponderosa Pine Forest Type	Dry Stream Bottom Type	Plains Cottonwood Type	Urban and Built-up Lands	Agricultural Lands
BIG GAME						
Mule deer	X		X	X		X
White-tailed deer		X		X		X
Pronghorn antelope	X		X	X		
UPLAND GAME BIRDS						
Sage grouse	X					
WATERFOWL AND WATER-ASSOCIATED BIRDS				X		
RAPTORS						
Golden eagles	X		X	X		X
Ferruginous hawk	X		X	X		X
THREATENED, ENDANGERED OR RARE SPECIES[a]						
Black-footed ferret	X					
Bald eagle	X	X		X		
Peregrine falcon	X					

[a]Threatened, Endangered or Rare species are discussed later in this report.

"Intermediate" endangered or rare species via discussed issues in this report.

	Tube Connection Airplane	Tubeset Tube Longwave Area	Bottom Tube Gas Screen	Tube Continuous Airplane	Tubes Point-up Signal Gun	Tubes Vertical Antenna
BIG GAME						
White Geese	X		X	X		X
White-tailed Deer		X		X		X
Grosbeak Sandpiper	X		X	X		
SMALL GAME RARE						
Gave Thrush	X					
WATERFOWL RARE						
WATER-ASSOCIATED BIRDS				X		
RAPTORS						
Golden Eagles	X		X	X		X
Peregrine Falcon	X					
INDEPENDENT THREATENED OR RARE PLANTS						
Black-footed Ferret	X					
Bald Eagle	X	X		X		
Peregrine Falcon	X					

"Intermediate" endangered or rare species via discussed issues in this report.

APPENDIX I-3.E-1

HABITAT TYPES WHICH SHOULD BE DISTURBED BY PROPOSED CONDOMINIUM
OCCURRENCE OF IMPORTANT WILDLIFE SPECIES IN ABERDEEN

to regional mule deer populations would be affected. Construction of all project components would temporarily remove 8,542 acres and permanently remove 2,768 acres of year-long mule deer habitat in eastern Wyoming and northeastern Colorado.

Antelope probably range over prairie grassland habitat at all proposed project components, and they are the most abundant big game species in the affected area. Only year-long habitat exists at project components and no critical habitat would be affected (Wyoming Game and Fish Department 1980). Construction of all project components would temporarily remove 8,352 acres and permanently remove 2,768 acres of year-long pronghorn antelope habitat in eastern Wyoming and northeastern Colorado.

The range of white-tailed deer in the project area is more restricted than that of mule deer and antelope. For the most part, white-tailed deer are restricted to riparian areas with a deciduous understory (Wyoming Game and Fish Department 1977). Only 29 acres of white-tailed deer habitat would be affected, none of which is classified as critical habitat by the Wyoming Game and Fish Department (1980).

Small Mammals

An aerial survey of the project area was conducted in the spring of 1981 to identify black-tailed prairie dog (*Cynomys ludovicianus*) towns. The results of this survey are presented in Table 2.6-2. The prairie dogs are the main diet of the black-footed ferret which is discussed under Threatened and Endangered Species later in this report.

Upland Game Birds

The Wyoming Game and Fish Department (1977a) lists the habitat of sage grouse as sagebrush plains. Sage grouse breed on strutting

TABLE 2.6-2

LOCATION OF PRAIRIE DOG TOWNS WITHIN TWO MILES OF PROPOSED PROJECT COMPONENTS

Component	Size (Acres)	Location
Product Pipeline		
Traversed at MP 67	229	Sec. 28, 29, 32, 33, T26N, R65W
Traversed at MP 148	26	Sec. 5, T13N, R65W
South Well Field		
Northwest corner of well field	2.5	Sec. 35, T33N, R74W
Northwest corner of well field	2.5	Sec. 1, T32N, R74W
Railroad		
0.1 mile north of the turn-around loop	28	Sec. 9, 16, T41N R70W
1.4 mile west of turn-around loop	59	Sec. 17, T41N, R70W
Traversed at MP 40.5	18	Sec. 21, 22, 27, 28, T41N, R70W
0.5 mile east of MP 40.5	7	Sec. 22, T41N, R70W
0.5 mile west of MP 39	12	Sec. 34, T41N, R70W
0.2 mile east of MP 38	186	Sec. 26, 35, 36, T41N, R70W
Traversed at MP 37	437	Sec. 35, 36, T41N, R70W; Sec. 1, 2, T40N, R70W
0.25 mile east of MP 30	163	Sec. 6, 7, T39N, R70W
0.35 mile east of MP 28.8	36	Sec. 12, T39N, R71W
Traversed at MP 27	738	Sec. 11, 13, 14, 15, T39N, R71W
0.75 mile west of MP 27	334	Sec. 16, 17, 20, 21, T39N, R71W
Mine		
Center of Mine	32	Sec. 1, T41N, R70W; Sec. 6, T41N, R69W
1.5 mile east of east mine boundary	31	Sec. 4, T41N, R69W
1.3 mile southeast of southeast mine boundary	73	Sec. 21, T41N, R69W

TABLE 2.6-2

LOCATION OF TRAILS AND ROADS WITHIN TWO MILES OF PROPOSED PROJECT COMPONENTS

Component	Miles (Acres)	Location
Product Pipeline		
Traversed at MP 67	224	Sec. 24, 25, 36, 34, T25N, R23W
Traversed at MP 145	26	Sec. 3, T12N, R4W
North Well Field		
Northwest corner of well field	2.5	Sec. 15, T23N, R14W
Northeast corner of well field	2.5	Sec. 1, T22N, R14W
Railroad		
0.1 mile north of the turn-around loop	28	Sec. 9, 16, T41N R10W
1.4 mile west of turn-around loop	35	Sec. 17, T41N, R10W
Traversed at MP 40.3	12	Sec. 21, 22, 27, 28, T41N, R10W
0.3 mile east of MP 40.3	7	Sec. 22, T41N, R10W
0.3 mile west of MP 39	13	Sec. 26, T41N, R10W
0.2 mile east of MP 38	18A	Sec. 34, 35, 36, T41N, R10W
Traversed at MP 37	41T	Sec. 25, 36, T41N, R10W; Sec. 1, 2, T40N, R10W
0.15 mile east of MP 36	16A	Sec. 6, 7, T39N, R10W
0.15 mile east of MP 28.8	36	Sec. 23, T39N, R11W
Traversed at MP 27	72B	Sec. 11, 13, 14, 23, T39N, R11W
0.15 mile west of MP 27	34A	Sec. 18, 17, 20, 21, T39N, R11W
Mine		
Center of Mine	72	Sec. 1, T41N, R10W; Sec. 6, T41N, R9W
1.5 mile east of east mine boundary	31	Sec. 4, T40N, R10W
1.5 mile southeast of southeast mine boundary	13	Sec. 21, T40N, R9W

grounds called leks in early spring. In Wyoming, strutting activity usually occurs from late February to mid-March (Harju 1979). Sage grouse leks are used, usually by the same birds, year after year, and according to Harju (1979), open sagebrush is preferred for strutting activities. Two leks are known to occur in the vicinity of proposed project components. One is on the proposed mine site (T. 42 N., R. 70 W, sec. 36); the second occurs approximately 0.2 miles east of railroad milepost 29 in T. 60 N., R. 69 W., sec. 12. Surveys conducted in April 1981 (WCC 1981d) failed to identify other leks in the vicinity of project components; these surveys confirm data provided by the Wyoming Game and Fish Department (1980).

Raptors

Many species of raptors occur in the vicinity of proposed project components. These species are listed by component in Appendix B of the Biology Technical Report (WCC 1981d). However, only golden eagles, ferruginous hawks, and red-tailed hawks are known to actually nest in the vicinity of proposed project components.

Raptor nests and roosts located within 1 mile of proposed project components are listed on Table 2.6-3. In Wyoming, golden eagles typically produce two eggs as early as late February but the majority are found in March (Williams and Matteson 1973). Golden eagles usually select cliff locations as nesting habitat, although a few tree and ground nests have been reported.

The ferruginous hawk also selects trees and cliffs as nest sites, although a number of ground nests have been reported (Williams and Matteson 1973); other sites include the tops of willows or tall cottonwoods along streams. The ferruginous hawk typically begins nesting in May and eggs are usually deposited in mid-May. The majority of the young leave the nest in July.

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Raptor nests and roosts located within 1 mile of proposed project components are listed on Table 2.5-2. In Wyoming, golden eagles typically produce two eggs as early as late February but the majority are found in March (Williams and Mathews 1972). Golden eagles usually select cliff locations as nesting habitat, although a few tree and ground nests have been reported.

The ferruginous hawk also selects trees and cliffs as nest sites, although a number of ground nests have been reported (Williams and Mathews 1972); other sites include the tops of willows or tall cottonwood along streams. The ferruginous hawk typically begins nesting in May and eggs are usually deposited in mid-May. The majority of the young leave the nest in July.

TABLE 2.6-3

KNOWN RAPTOR NESTS AND ROOSTS THAT OCCUR WITHIN 1 MILE OF PROJECT COMPONENTS

Nest or Roost	Location	Proximity to Component
COMBS RESERVOIR		
Golden eagle roost	T. 33 N., R. 72 W., sec. 12	Western limit of proposed Combs Reservoir dam
WATER PIPELINES		
Red-tailed hawk nest	T. 33 N., R. 71 W., sec. 7	Banks of North Platte River at proposed South Well Field to plant site crossing
RAILROAD		
Golden eagle/bald eagle winter roost	T. 41 N., R. 70 W., sec. 25	1.0 miles from corridor
Golden eagle nest	T. 40 N., R. 70 W., sec. 1	0.3 miles from corridor
Golden eagle nest	T. 40 N., R. 69 W., sec. 5	1.0 miles from corridor
Golden eagle nest	T. 39 N., R. 70 W., sec. 27	0.7 miles from corridor
Ferruginous hawk nest	T. 39 N., R. 70 W., sec. 27	0.6 miles from corridor
Ferruginous hawk nest	T. 38 N., R. 70 W., sec. 35	1.0 miles from corridor
Golden eagle nest	T. 37 N., R. 70 W., sec. 34	0.5 miles from corridor
MINE		
Golden eagle nest	T. 41 N., R. 70 W., sec. 15	Within the mine boundary
Golden eagle nest	T. 41 N., R. 69 W., sec. 8	Within the mine boundary
PRODUCT PIPELINE		
Golden eagle nest	T. 30 N., R. 66 W., sec. 29	0.3 miles south of milepost 39.1
Golden eagle nest	T. 19 N., R. 66 W., sec. 11	0.15 miles east of milepost 103

MILNER 1 SITE OR AREIECI COORDINATE
ENGINE STATION BASIC AND SUPPLE DATA DECK

ITEM E-3.2-1

Name or Source	Location	Approximate to nearest
CONGO FRANCHVILLE		
Golden Eagle Lodge	1° 11' N., 2° 17' W. near 11	Minimum limit of Brazzaville (Lope Brazzaville) from
AVIAN AIRCRAFT		
Sea-Castle Hotel Site	1° 11' N., 2° 17' W. near 1	Basis of Gulfe Airline Start at Brazzaville Hotel
		Will Always to Direct Area Corrected
FAIRMOUND		
Golden Eagle Lodge/Pale Eagle	1° 41' N., 2° 16' W. near 11	1.0 Miles from Airline
Minute Lodge		
Golden Eagle Hotel	1° 54' N., 2° 10' E. near 1	0.1 Miles from Airline
Golden Eagle Hotel	1° 40' N., 2° 05' W. near 1	1.0 Miles from Airline
Golden Eagle Hotel	1° 41' N., 2° 10' W. near 11	0.1 Miles from Airline
Fairmoundions Hotel Hotel	1° 55' N., 2° 10' W. near 11	0.4 Miles from Airline
Fairmoundions Hotel Hotel	1° 55' N., 2° 10' W. near 11	0.5 Miles from Airline
Golden Eagle Hotel	1° 51' N., 2° 06' W. near 11	0.5 Miles from Airline
HINE		
Golden Eagle Hotel	1° 41' N., 2° 10' W. near 11	Within the Miles Boundary
Golden Eagle Hotel	1° 41' N., 2° 05' W. near 1	Within the Miles Boundary
SOUTHOUT AIRAIRLINE		
Golden Eagle Hotel	1° 54' N., 2° 04' W. near 11	0.12 Miles Hotel to Airlabout 101
Golden Eagle Hotel	1° 54' N., 2° 05' W. near 11	0.1 Miles Hotel to Airlabout 101
Golden Eagle Hotel	1° 54' N., 2° 04' W. near 11	0.12 Miles Hotel to Airlabout 101

The red-tailed hawk begins nesting in April and early May, which is earlier than most other Wyoming hawks (Williams and Matteson 1973). Large stick nests are usually built in the tops of small trees. Fledgings typically occur ten weeks after eggs are laid (mid-July).

2.7 AQUATIC BIOLOGY

Discussion of aquatic organisms and habitats will focus on fishes and macroinvertebrates, since other components of the freshwater community, including phytoplankton, zooplankton, periphyton, and vascular plants, are not expected to be significantly affected by project construction, operation, maintenance, or abandonment. No threatened, endangered, or other sensitive classification aquatic species would be affected by the proposed project. More extensive and detailed data on aquatic biological resources are presented in the Biological Technical Report (WCC 1981).

Many streams in the project area have been classified by the U.S. Fish and Wildlife Service, the Wyoming Game and Fish Department (1977), and/or the Wyoming Game and Fish Department (1978). These classification systems are based primarily on the biological and physical integrity and quality of the streams. Fishery-oriented definitions for the classification systems are presented in Table 2.7-1.

All perennial, intermittent, or emphemeral Wyoming streams affected by the proposed project are contained within either the Cheyenne or North Platte River basin; Table 2.7-2 lists characteristics of potentially affected classified streams. Five intermittent or ephemeral streams that would be crossed by the product pipeline in Colorado lie within the North Platte River basin and are unclassified by the U.S. Fish and Wildlife Service (1979). It is presumed that they, like most unclassified Wyoming streams, are low production waters. These Colorado streams will not be discussed further in this document.

Taxonomic lists of fishes collected from the Cheyenne River and North Platte River basins are presented in Tables 2.7-3 and 2.7-4,

TABLE 2.7-1

STREAM EVALUATION DEFINITIONS USED BY THE U.S. FISH AND WILDLIFE SERVICE AND WYOMING GAME AND FISH COMMISSION (1978), AND WYOMING GAME AND FISH DEPARTMENT (1977b)

U.S. Fish and Wildlife Service and Wyoming Game and Fish Commission (1978)

Value Class I - Highest-value fishery resource

Value Class II - High-priority fishery resource

Value Class III - Substantial fishery resource

Value Class IV - Limited fishery resource

Wyoming Game and Fish Department (1977b):

Class 1 - Premium trout waters - fisheries of national importance

Class 2 - Very good trout waters - fisheries of statewide importance

Class 3 - Important trout waters - fisheries of regional importance

Class 4 - Low production waters - fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure

Class 5 - Very low production waters - often incapable of sustaining a fishery

CHARACTERISTICS OF SELECTED CLASSIFIED STREAMS POTENTIALLY AFFECTED BY COMPONENTS OF THE PROPOSED PROJECT

Stream Identification	Flow (I=intermittent, P=perennial)	Stream Classification[a]	River Basin	Project Component(s) Potentially Affecting the Stream
LaPrele Creek	I	III	North Platte River	South well field, water pipelines, transmission lines, operation of LaPrele Reservoir
Little Box Elder Creek	I	III	North Platte River	South well field, water pipelines, transmission lines
Box Elder Creek	P	5	North Platte River	South well field, water pipelines,
Soldier Creek	I	5	North Platte River	Combs Reservoir
North Platte River	P	III	North Platte River	River intake, water pipelines, product pipeline, Combs Reservoir
West Side Ditch	P	5	North Platte River	Water pipeline
Morton Ditch	P	5	North Platte River	Water pipeline
Antelope Creek	I	5	Cheyenne River	Railroad
Porcupine Creek	I	5	Cheyenne River	Railroad
Broom Creek	P	IV	North Platte River	Product pipeline
Laramie River	P	IV	North Platte River	Product pipeline
Bear Creek	P	IV	North Platte River	Product pipeline
Little Bear Creek	P	IV	North Platte River	Product pipeline
Horse Creek	P	IV	North Platte River	Product pipeline
Patten Creek	I	IV	North Platte River	Product pipeline
Deer Creek	I	IV	North Platte River	Product pipeline

[a]Roman numerals indicate classification by the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Commission (1978). Arabic numerals indicate classification by the Wyoming Game and Fish Department (1977b). See Table 2.7-1 for stream classification definitions.

TABLE 3.1-1

CHARACTERIZATION OF SELECTED CLASSIFIED FOREIGN AGRICULTURE

FARMERS IN COMMUNITIES OF THE PROVINCE PESHAWAR

Identification Sketch	Experience(s) (I=Inexperienced, Alpha Numeric)	Tractor Current-Years	Crops Grown	Significant Farm Activities
Lafarie Cocoa	I	III	Sorghum Alfalfa Sheep	Sorghum meal flour, Market Bananas, transmigration flows
Lafarie Rice Flour Cheese	I	III	Sorghum Alfalfa Sheep	Sorghum meal flour, Market Bananas, transmigration flows
Lux Eight Cocoa	5	I	Sorghum Alfalfa Sheep	Sorghum meal flour, Market Bananas,
Boulder Cocoa	I	3	Sorghum Alfalfa Sheep	Cocoa Beans
Sorgo Farmer Sheep	5	III	Sorghum Alfalfa Sheep	Sheep Farmer, Market Bananas, Sorghum meal flour, cocoa Beans
Mount Berry Sheep	5	3	Sorghum Alfalfa Sheep	Market Bananas
Mountain Berry	5	3	Sorghum Alfalfa Sheep	Market Bananas
Macadamia Cocoa	I	3	Cashews Sheep	Cashews
Macadamia Cocoa	I	3	Cashews Sheep	Cashews
Bamboo Cocoa	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Lumbrio Sheep	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Beef Cocoa	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Lafarie Beef Cocoa	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Matar Cocoa	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Lafarie Cocoa	5	IA	Sorghum Alfalfa Sheep	Transport Bananas
Beef Cocoa	I	IA	Sorghum Alfalfa Sheep	Transport Bananas
Lafarie Cocoa	I	IA	Sorghum Alfalfa Sheep	Transport Bananas
Lafarie Cocoa	I	IA	Sorghum Alfalfa Sheep	Transport Bananas

*Farmer commercial indicates characterization of the U.S. farm and difficulties operate and the farmer under the farm commercial (1978). Sample 3.1-1 for farmer characterization qualifications.

TABLE 2.7-3

FISHES OF THE CHEYENNE RIVER BASIN, WYOMING

Common Name	Scientific Name
Minnows and Carps	Family Cyprinidae
Golden shiner	*Notemigonus crysoleucas*
Flathead chub	*Hybopsis gracilis*
Longnose dace	*Rhinichthus cataractae*
Sand shiner	*Notropis stramineus*
Plains minnow	*Hybognathus placitus*
Fathead minnow	*Pimephales notatus*
Suckers	Family Catostomidae
River carpsucker	*Carpiodes carpio*
White sucker	*Catostomus commersoni*
Mountain sucker	*Catostomus platyrhynchus*
Catfishes	Family Ictaluridae
Black bullhead	*Ictalurus melas*
Channel catfish	*Ictalurus punctatus*
Killifishes	Family Cyprinodontidae
Plains topminnow	*Fundulus sciadicus*
Plains killifish	*Fundulus kansae*
Sunfishes	Family Centrarchidae
Green sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Perches	Family Percidae
Plains orangethroat darter	*Etheostoma spectabile pulchellum*

Source: Baxter and Simon 1970.

TABLE 1.7-3

FISHES OF THE CHEYENNE RIVER BASIN, WYOMING

Common Name	Scientific Name
Minnows and Carps	Family Cyprinidae
Golden shiner	Notemigonus crysoleucas
Flathead chub	Hybopsis gracilis
Longnose dace	Rhinichthys cataractae
Sand shiner	Notropis stramineus
Plains minnow	Hybognathus placitus
Fathead minnow	Pimephales promelas
Suckers	Family Catostomidae
River carpsucker	Carpiodes carpio
White sucker	Catostomus commersoni
Bonneville sucker	Catostomus plebeius
Catfishes	Family Ictaluridae
Black bullhead	Ictalurus melas
Channel catfish	Ictalurus punctatus
Killifishes	Family Cyprinodontidae
Plains topminnow	Fundulus sciadicus
Plains killifish	Fundulus kansae
Sunfishes	Family Centrarchidae
Green sunfish	Lepomis cyanellus
Bluegill	Lepomis macrochirus
Perches	Family Percidae
Plains orangethroat darter	Etheostoma cragini
	Percina caprodes

Source: Baxter and Simon 1970.

TABLE 2.7-4

FISHES OF THE NORTH PLATTE RIVER BASIN

Common Name	Scientific Name
Sturgeons	Family Acipenseridae
Shovelnose sturgeon	*Scaphirhynchus platorynchus*
Herrings	Family Clupeidae
Gizzard shad	*Dorosoma cepedianum*
Trouts	Family Salmonidae
Rainbow trout	*Salmo gairdneri*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Pikes	Family Esocidae
Northern pike	*Esox lucius*
Minnows	Family Cyprinidae
Carp	*Cyprinus carpio*
Creek chub	*Semotilus atromaculatus*
Hornyhead chub	*Nocomis biguttatus*
Flathead chub	*Hybopsis gracilis*
Longnose dace	*Rhinichthys cataractae*
Suckermouth minnow	*Phenacobius mirabilis*
Common shiner	*Notropis cornutus*
River shiner	*Notropis blennius*
Red shiner	*Notropis lutrensis*
Bigmouth shiner	*Notropis dorsalis*
Sand shiner	*Notropis stramineus missuriensis*
Brassy minnow	*Hybognathus hankinsoni*
Plains minnow	*Hybognathus placitus*
Fathead minnow	*Pimephales promelas*
Stoneroller	*Campostoma anomalum*
Suckers	Family Catostomidae
Quillback	*Carpiodes cyprinus*
River carpsucker	*Carpiodes carpio*
Northern redhorse	*Moxostoma macrolepidotum*
White sucker	*Catostomus commersoni*
Longnose sucker	*Catostomus catostomus*
Catfishes	Family Ictaluridae
Black bullhead	*Ictalurus melas*
Channel catfish	*Ictalurus punctatus*
Stonecat	*Noturus flavus*

TABLE 2.1-4

FISHES OF THE NORTH PLATTE RIVER BASIN

Common Name	Scientific Name
Sturgeons	Family Acipenseridae
Shovelnose sturgeon	Scaphirhynchus platorynchus
Herrings	Family Clupeidae
Gizzard shad	Dorosoma cepedianum
Trouts	Family Salmonidae
Rainbow trout	Salmo gairdneri
Brown trout	Salmo trutta
Brook trout	Salvelinus fontinalis
Pikes	Family Esocidae
Northern pike	Esox lucius
Minnows	Family Cyprinidae
Carp	Cyprinus carpio
Creek chub	Semotilus atromaculatus
Horyhead chub	Nocomis biguttatus
Flathead chub	Hybopsis gracilis
Longnose dace	Rhinichthys cataractae
Suckermouth minnow	Phenacobius mirabilis
Common shiner	Notropis cornutus
River shiner	Notropis blennius
Red shiner	Notropis lutrensis
Bigmouth shiner	Notropis dorsalis
Sand shiner	Notropis stramineus
Brassy minnow	Hybognathus hankinsoni
Plains minnow	Hybognathus placitus
Fathead minnow	Pimephales promelas
Stoneroller	Campostoma anomalum
Suckers	Family Catostomidae
Quillback	Carpiodes cyprinus
River carpsucker	Carpiodes carpio
Northern redhorse	Moxostoma macrolepidotum
White sucker	Catostomus commersoni
Longnose sucker	Catostomus catostomus
Catfishes	Family Ictaluridae
Black bullhead	Ictalurus melas
Channel catfish	Ictalurus punctatus
Stonecat	Noturus flavus

TABLE 2.7-4 Concluded

FISHES OF THE NORTH PLATTE RIVER BASIN

Common Name	Scientific Name
Killifishes	Family Cyprinodontidae
Plains killifish	Fundulus kansae
Sunfishes	Family Centrarchidae
Green sunfish	Lepomis cyanellus
Pumpkinseed	Lepomis gibbosus
Perches	Family Percidae
Walleye	Stizostedion vitreum vitreum
Yellow perch	Perca flavescens
Iowa darter	Etheostoma exile

Sources: Baxter and Simon 1970; Wyoming Game and Fish Department 1979.

TABLE 2.7-4 Concluded

FISHES OF THE NORTH PLATTE RIVER BASIN

Common Name	Scientific Name
Killifishes	Family Cyprinodontidae
Plains killifish	Fundulus kansae
Sunfishes	Family Centrarchidae
Green sunfish	Lepomis cyanellus
Pumpkinseed	Lepomis gibbosus
Perches	Family Percidae
Walleye	Stizostedion vitreum vitreum
Yellow perch	Perca flavescens
Iowa darter	Etheostoma exile

Source: Baxter and Simon 1970; Wyoming Game and Fish Department 1979.

respectively. Of the species that occur in these drainages, green sunfish, perch, catfishes, and trouts are considered high-value game or food fishes. The green sunfish, however, often exhibits stunted growth in eastern Wyoming drainages (Wesche and Johnson 1980). These taxonomic lists are expected to include the fish communities in all the potentially affected rivers and streams.

Freshwater invertebrates have been surveyed at and near the proposed mine site, and at the intake on the North Platte River (Wesche and Johnson 1980; Ecology Consultants, Inc. 1975). The data indicate that potentially affected streams probably maintain macroinvertebrate communities dominated by amphipods, worms, snails, clams, mayflies, dragonflies and damselflies, caddisflies, beetles, flies, and stoneflies.

Table 2.7-5 indicates, by project component, the total numbers of streams potentially affected by construction, operation, maintenance, and/or abandonment of the project; those of interest due to their flow characteristics or fisheries classifications are discussed below.

The North Platte River in the project area is regulated by several upstream and downstream impoundments. Water quality data from Ecology Consultants, Inc. (1975) indicated no biologically stressful conditions at that time. Periphyton, phytoplankton, and invertebrate populations were dense and diverse (Ecology Consultants, Inc. 1975). Game fishes recorded from the North Platte River include rainbow and brown trout, walleye, yellow perch, channel catfish, and black bullhead (Ecology Consultants, Inc. 1975; Wyoming Game and Fish Department 1979).

The Laramie River is a Class IV river and cannot sustain heavy fishing pressure due to a lack of cover, a short growing season, and

respectively. Of the species that occur in these drainages, green sunfish, perch, catfishes, and trouts are considered high-value game or food fishes. The green sunfish, however, often exhibits stunted growth in eastern Wyoming drainages (Wesche and Johnson 1980). These taxonomic likes are expected to include the fish communities in all the potentially affected rivers and streams.

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Table 2.7-3 indicates, by project component, the total numbers of streams potentially affected by construction, operation, maintenance, and/or abandonment of the project; those of interest due to their flow characteristics or fisheries classifications are discussed below.

The North Platte River in the project area is regulated by several upstream and downstream impoundments. Water quality data from Ecology Consultants, Inc. (1975) indicated no biologically stressful conditions at that time. Periphyton, phytoplankton, and invertebrate populations were dense and diverse (Ecology Consultants, Inc. 1975). Game fishes recorded from the North Platte River include rainbow and brown trout, walleye, yellow perch, channel catfish, and black bullhead (Ecology Consultants, Inc. 1975; Wyoming Game and Fish Department 1979).

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TABLE 2.7-5

TOTAL NUMBERS OF STREAMS POTENTIALLY AFFECTED BY PROJECT COMPONENTS

Project Component	Number of Streams Potentially Affected	
	Intermittent	Perennial
Mine	7	
Railroad	39	
Plant	3	
North Well Field	5	
South Well Field	4	1
Transmission Lines	26	
Access Roads	4	
Operation of LaPrele Reservoir	1	1
Combs Reservoir	1	1
Water Pipelines	23	8
North Platte River Intake		1
Product Pipeline	108 (103 in Wyoming, 5 in Colorado)	11

TABLE 2.7-5

TOTAL NUMBERS OF STREAMS POTENTIALLY AFFECTED BY PROJECT COMPONENTS

Project Component	Number of Streams Potentially Affected	
	Intermittent	Perennial
Mine	7	
Railroad	19	
Plant	3	
North Well Field	5	
South Well Field	4	1
Transmission Lines	36	
Access Roads	4	
Operation of Lafarge Reservoir	1	1
Combs Reservoir	1	1
Water Pipelines	13	2
North Platte River Intake		1
Product Pipeline	108 (103 in Wyoming, 5 in Colorado)	11

shallow waters. The only game fish of significance in this river is the brown trout (Wyoming Game and Fish Department 1979).

LaPrele and Little Box Elder creeks have been classified as Class III streams by the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department (1978), and are considered to be important trout waters in eastern Wyoming. Both creeks have been surveyed by the Wyoming Game and Fish Department (1979); rainbow and brown trout are found in LaPrele Creek, and rainbow and brook trout are found in Little Box Elder Creek.

Patten Creek fisheries are limited: brook trout is the only fish reported by the Wyoming Game and Fish Department (1979). This stream sustains an average regional fishing pressure of three fisherman days per year per mile. Bear Creek sustains a brook trout fishery averaging four fisherman days per year per mile (Wyoming Game and Fish Department 1979). Little Bear Creek, a tributary of Bear Creek, sustains a fishing pressure of two fisherman days per year per mile.

Horse Creek maintains a fishing pressure of seven fisherman days per year per mile. The majority of trout harvested are raised to catchable size in a hatchery because local fishing pressure exceeds the supply available from natural reproduction and stocking of fry (Wyoming Game and Fish Department 1979).

2.8 RARE AND ENDANGERED SPECIES

In response to the BLM request, the U.S. Fish and Wildlife Service has identified the following federally protected (endangered) species in the project area: the black-footed ferret, peregrine falcon, bald eagle, and whooping crane.

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Pattee Creek fisheries are limited: brook trout is the only fish reported by the Wyoming Game and Fish Department (1979). This stream sustains an average regional fishing pressure of three fisherman days per year per mile. Bear Creek sustains a brook trout fishery averaging four fisherman days per year per mile (Wyoming Game and Fish Department 1979). Little Bear Creek, a tributary of Bear Creek, sustains a fishing pressure of two fisherman days per year per mile.

Horse Creek maintains a fishing pressure of seven fisherman days per year per mile. The majority of trout harvested are raised to catchable size in a hatchery because local fishing pressure exceeds the supply available from natural reproduction and stocking of fry (Wyoming Game and Fish Department 1979).

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The black-footed ferret is endangered throughout its entire range (Federal Register 32(4001): March 11, 1967). The original range of the black-footed ferret is believed to have included all of east and central Wyoming (Hall and Kelson 1959), but recent evidence has revealed confirmed skelatal remains in southwest Wyoming (Martin and Schroeder 1978). The entire project area lies within the suspected original range of the black-footed ferret.

The ferret is characteristic of the short and midgrass grasslands and their principal habitat is prairie dog colonies (Black-footed Ferret Recovery Team 1978). Hillman (1968) indicated that ferrets feed entirely on prairie dogs even when other prey species were available.

The bald eagle (Haliaeetus leucocephalus) is classified as endangered in all the coterminous states except Washington, Oregon, Maine, Wisconsin, and Minnesota, and is listed as threatened in those five states, as published in the Federal Register (32 FR 4001, March 11, 1967; and 43 FR 6233, February 14, 1978). The bald eagle formerly bred throughout much of the United States; now it breeds primarily in the northern states and in Florida. During the winter, the bald eagle occurs along many bodies of water, especially larger rivers and lakes, throughout eastern Wyoming.

The bald eagle is primarily a fish-eater, but it also consumes carrion and will catch crippled waterfowl. Nests are usually built in tall trees and are renovated yearly. Eagles defend their nesting territories but do not defend any territory during migration or winter. Large numbers of bald eagles have been reported to gather at communal roosts, usually near a food source or shelter (Snow 1973).

No bald eagle nesting occurs in the vicinity of proposed project components (Wyoming Game and Fish Department 1980a) although

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No bald eagle nesting occurs in the vicinity of proposed project components (Wyoming Game and Fish Department 1980a) although

overwintering eagles could be encountered at all project components especially in the vicinity of rivers and perennial streams (i.e., Antelope Creek, North Platte River, and Laramie River). One bald eagle winter roost (T. 41 N., R. 70 W., sec. 25) is located 1.0 mile east of the railroad corridor on the Converse-Campbell county line.

The American peregrine falcon (Falco peregrinus anatum) occurs in Canada, the United States, and Mexico. This species is classified as endangered throughout its entire range, as published in the Federal Register (35 FR 16047, October 13, 1970; 35 FR 8495, June 2, 1950; and 35 FR 18320, December 2, 1970).

The peregrine falcon formerly bred and wintered throughout most of North America, with the primary exception being the southeastern portion of the United States. This falcon still breeds throughout much of the western United States but is fairly rare in the East.

Most peregrine falcon nests are located on cliffs, particularly ones that are extremely high, frequently overlooking water and offering an extensive view. Not all such cliffs are presently occupied, nor have they historically been occupied. An adequate food supply in the vicinity of the nest location is also a necessity. Nesting sites are normally reused yearly (Snow 1972).

Williams and Matteson (1973) stated that the peregrine falcon is not common as a summer resident in Wyoming but is more frequently encountered as a migrant. Suitable peregrine falcon nesting habitat is lacking in the project area. Consequently, the project will have no effect on this species.

The whooping crane (Grus americana) is listed as endangered by the U.S. Fish and Wildlife Service (32 FR 4001, March 11, 1967;

overwintering eagles could be encountered at all project components especially in the vicinity of rivers and perennial streams (i.e., Antelope Creek, North Platte River, and Laramie River). One bald eagle winter roost (T. 41 N., R. 70 W., sec. 25) is located 1.0 mile east of the railroad corridor on the Converse-Campbell county line.

The American peregrine falcon (*Falco peregrinus anatum*) occurs in Canada, the United States, and Mexico. This species is classified as endangered throughout its entire range, as published in the Federal Register (35 FR 16647, October 13, 1970; 35 FR 8497, June 2, 1970; and 35 FR 18320, December 2, 1970).

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The whooping crane (*Grus americana*) is listed as endangered by the U.S. Fish and Wildlife Service (32 FR 4001, March 11, 1967;

35 FR 8495, June 2, 1970). In May 1978 (43 FR 20938, May 15, 1978), the Fish and Wildlife Service designated the area of the Platte River from Lexington to Denman, Nebraska (about 53 river miles in the "Big Bend" area), as critical habitat for the whooping crane. The critical habitat is approximately 320 river miles east of the proposed intake.

The whooping cranes use the Big Bend area in the spring months (late February to early May) as a staging area, and in the fall months as a stopover point, during their normal migratory flights (Aronson and Ellis 1979). Wet meadows adjacent to the river are important feeding areas for the cranes (Frith 1974). An evaluation of the potential effect of the proposed project on whooping crane habitat is currently being conducted by the BLM and the U.S. Fish and Wildlife Service.

2.9 RECREATION RESOURCES

For purposes of this assessment, the majority of recreation resources considered are formally designated areas managed to both preserve and further their use for play, amusement, and relaxation. Other recreation areas included are the unmanaged and dispersed recreation areas (such as sites used for fishing, hunting, hiking, and offroad vehicle [ORV] use) within the geographic region of influence. Recreation resources are categorized under two major subheadings: urban-oriented resources (those parks and facilities within the incorporated boundaries of cities and towns), and nonurban resources (all of the parks, public lands, dispersed use areas, waterways, and visitor attractions outside the defined urban area). Urban recreation resources are discussed within the socioeconomics section.

Nonurban Recreation Resources

Nonurban recreation resources include the managed areas and dispersed use areas that could be directly or indirectly affected by the construction, operation, maintenance, or abandonment phases of the project components and alternatives. By definition, this includes recreation lands actually traversed by the project, and those areas where project activities (such as construction noise, dust, and odor) might be noticeable enough to affect the quality of the recreation experience at nearby recreation sites. Also included in the recreation inventory are recreation use areas and attractions within a 60-mile (10-county region) radius of the cities and towns where the project labor force is likely to reside, and where increased visitor use could affect the recreation resource. Figure 2.9-1 shows major recreation areas in the region, and Table 2.9-1 identifies the major resource areas, their respective managing agencies, and their size and location by county. Table 2.9-2 lists the primary, managed recreation areas within the driving distances from the individual communities of

2.9 RECREATION RESOURCES

For purposes of this assessment, the majority of recreation resources considered are formally designated areas managed to both preserve and further their use for play, amusement, and relaxation. Other recreation areas included are the unmanaged and dispersed recreation areas (such as sites used for fishing, hunting, hiking, and offroad vehicle [ORV] use) within the geographic region of influence. Recreation resources are categorized under two major subheadings: urban-oriented resources (those parks and facilities within the incorporated boundaries of cities and towns), and nonurban resources (all of the parks, public lands, dispersed use areas, waterways, and visitor attractions outside the defined urban area). Urban recreation resources are discussed within the socioeconomic section.

Nonurban Recreation Resources

Nonurban recreation resources include the managed areas and dispersed use areas that could be directly or indirectly affected by the construction, operation, maintenance, or abandonment phases of the project components and alternatives. By definition, this includes recreation lands actually traversed by the project, and those areas where project activities (such as construction noise, dust, and odor) might be noticeable enough to affect the quality of the recreation experience at nearby recreation sites. Also included in the recreation inventory are recreation use areas and attractions within a 60-mile (10-county region) radius of the cities and towns where the project labor force is likely to reside, and where increased visitor use could affect the recreation resource. Figure 2.9-1 shows major recreation areas in the region, and Table 2.9-1 identifies the major resource areas, their respective managing agencies, and their size and location by county. Table 2.9-2 lists the primary, managed recreation areas within the driving distance from the individual communities of

Figure 2.9-1
REGIONAL RECREATION MAP

Source: BLM 1979

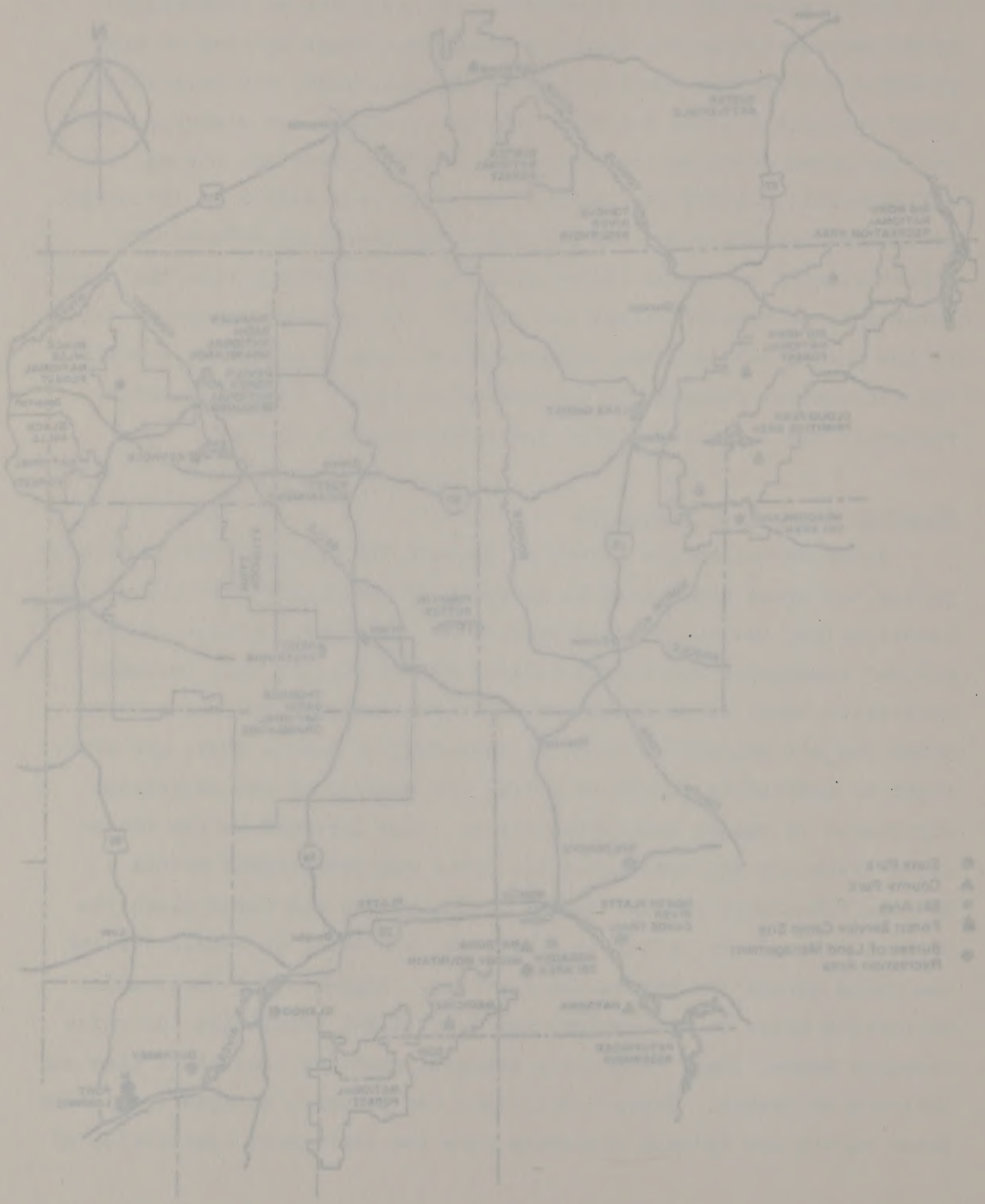

Figure 2.4-1
REGIONAL RECREATION MAP

Source: BLM 1979

TABLE 2.9-1

MAJOR RECREATION RESOURCES WITHIN THE REGION OF INFLUENCE

Name of Resource	Managing Agency	Size (acres)	Location (county)
Federal			
Thunder Basin National Grasslands	Forest Service	572,951	Campbell, Weston, Converse
Medicine Bow--Laramie Peak	Forest Service	1,401,938	Converse
Black Hills	Forest Service	201,126	Crook
Big Horn National Forest	Forest Service	1,115,125	Johnson
Devils Tower	National Park Service	1,347	Crook
Big Horn National Recreation Area	National Park Service	739	Johnson
Fort Laramie	National Park Service	563	Goshen
Middle Fork	Bureau of Land Management	46,000	Johnson, Natrona
Muddy Mountain	Bureau of Land Management	12,000	Natrona
Goldeneye	Bureau of Land Management	733	Natrona
Platte River	Bureau of Land Management	1,280	Converse
Alcova Reservoir	Water and Power Resources and Natrona County Parks Board	20[a]	Natrona
Gray Reef Reservoir	Water and Power Resources and Natrona County Parks Board	15[a]	Natrona
Kortes Reservoir	Water and Power Resources and Wyoming Game and Fish	405[a]	Carbon
Pathfinder Reservoir	Water and Power Resources and Natrona County Parks Board	117[a]	Natrona, Carbon
State			
Glendo State Park	Wyoming Recreation Commission	8,900	Platte
Guernsey Reservoir	Wyoming Recreation Commission	5,700	Platte
Keyhole State Park	Wyoming Recreation Commission	6,700	Crook
Seminoe Reservoir	Wyoming Recreation Commission	1,700	
Fort Fetterman State Historic Site	Wyoming Recreation Commission	60.5	Converse
Independence Rock	Wyoming Recreation Commission	960	Natrona
County			
Ayres Natural Bridge Park	Converse County		Converse
Boxelder	Converse County		Converse
Fort Casper Park	Natrona County		Natrona
Casper Mountain Park	Natrona County	400	Natrona
Beartrap Meadow Park	Natrona County	160	Natrona
Ponderosa Park	Natrona County	2,000	Natrona

[a]Shoreline miles

TABLE 2.5-1

MAJOR RECREATION RESOURCES WITHIN THE REGION OF INFLUENCE

Name of Resource	Managing Agency	Size (acres)	Location (county)
Federal			
Tonto Basin	Forest Service	571,571	Coconino, Navajo, Gila
National Grasslands			
Medicine Bow--Laramie Park	Forest Service	1,401,419	Coconino
Black Mills	Forest Service	201,130	Crook
Big Horn National Forest	Forest Service	1,115,115	Johnson
Devils Tower			
Big Horn National	National Park Service	1,341	Crook
Bighorn Canyon	National Park Service	139	Johnson
Bighorn Area			
Fort Laramie			
Middle Park	National Park Service	363	Grand
Rocky Mountain	Bureau of Land Management	46,000	Larimer, Weld
Colorado	Bureau of Land Management	13,000	Mesa
Pueblo Alvar	Bureau of Land Management	171	Mesa
Alvar Reservoir	Bureau of Land Management	1,396	Cheyenne
	Water and Power Resources and Maricopa County Parks Board	28*	Maricopa
Cave Creek Reservoir	Water and Power Resources and Maricopa County Parks Board	13*	Maricopa
Saguaro Reservoir	Water and Power Resources and Maricopa County Parks Board	405*	Pinal
Pathfinder Reservoir	Water and Power Resources and Maricopa County Parks Board	111*	Maricopa, Pinal
State			
Cheyenne State Park	Wyoming Recreation Commission	8,000	Platte
Guernsey Reservoir	Wyoming Recreation Commission	5,700	Platte
Keyhole State Park	Wyoming Recreation Commission	4,700	Crook
Seminoe Reservoir	Wyoming Recreation Commission	1,700	
Fort Fetterman	Wyoming Recreation Commission	40.5	Converse
Glade Electric Site			
Independence Rock	Wyoming Recreation Commission	850	Natrona
County			
Ayres Natural Bridge Park	Converse County		Converse
Boxelder	Converse County		Converse
Fort Caspar Park	Natrona County		Natrona
Casper Mountain Park	Natrona County	400	Natrona
Sunrise Meadow Park	Natrona County	180	Natrona
Pahaska Park	Natrona County	4,000	Natrona

*Shoreline miles

TABLE 2.9-2

MANAGED RECREATIONS AREAS WITHIN DRIVING DISTANCE[a]
OF COMMUNITIES OF RESIDENCE

Douglas	Glenrock	Wright	Gillette	Newcastle	Casper
Medicine Bow	Medicine Bow	Medicine Bow			Medicine Bow
		Black Hills	Black Hills	Black Hills	Black Hills
Big Horn National Forest	Big Horn National Forest	Big Horn National Forest	Big Horn National Forest	Big Horn National Forest	
			Devils Tower	Devils Tower	
Fort Laramie			Middle Fork		
Muddy Mountain	Muddy Mountain				
					Goldeneye
					Alcova
					Gray Reef
					Kortes
					Pathfinder
Glendo State Park	Glendo State Park				
Guernsey Reservoir and State Park					
			Keyhole State Park	Keyhole State Park	
Seminoe Reservoir					Seminoe Reservoir
Fort Fetterman	Fort Fetterman				Fort Fetterman
					Independence Park
Ayres Natural Bridge	Ayres Natural Bridge				Ayres Natural Bridge
Boxelder Park	Boxelder Park				
Fort Casper	Fort Casper				Fort Casper
Casper Mountain					Casper Mountain
Beartrap Meadow					Beartrap Meadow
Ponderosa Park					Ponderosa Park

[a]Driving distance is less than 60 miles for all but the larger recreation use areas, where longer distances may be warranted.

FIGURE 2-8-3

MEANSED SECRETARIAT RADIO MISSIONS DEPARTS DISTANCE,
% COMMUNITIES IN REFERENCE

Doorjam	Cincinnati	Airport	Cincinnati	Hammondsville	Cambridge
Mandrillus Zoo	Mandrillus Zoo	Mandrillus Zoo			Mandrillus Zoo
		Black Hills	Black Hills	Black Hills	Black Hills
Air Force	Air Force	Air Force	Air Force	Air Force	
National	National	National	National	National	
Terminal	Terminal	Terminal	Terminal	Terminal	
			Penalty Tower	Penalty Tower	
			Airship Port		
Port Lawrence					
Marsh Mountain	Marsh Mountain				
					Cochrane
					Tricorn
					Cove Point
					Cochrane
					Interstate
Circle Circle	Circle Circle				
Tree	Tree				
Commerce					
Commerce Hall					
Green Park					
			Interstate	Exchange	
				Green Park	
Dominion					Dominion
Commerce					Commerce
Port Terminal	Port Terminal				Port Terminal
Interstate					Interstate
Tree					Tree
Valve Building	Valve Building				Valve Building
Building	Building				Building
Powerline Park	Powerline Park				
Port Center	Port Center				Port Center
Center Monument					Center Monument
Powerline Station					Powerline Station
Foundation Park					Foundation Park

"Airship distance is least from 22 meters but 8% of the longest terrestrial data mixed" shows longest distances must be mentioned.

influence. Tables D-1 through D-6 in Appendix D identify types of facilities found within the federal, state, and county recreation areas.

Recreation resources include federal, state, and county parks, trails, and waterways where the following types of recreational activities take place: sightseeing, hunting, fishing, winter sports, float-boating, swimming, camping, picnicking, off-road vehicle operation, hiking, and so on. Because this general region is primarily semiarid, the unique qualities of water are stressed to include all recreational rivers, streams, and reservoirs in the area of influence.

Lands in the immediate vicinity (within 5 miles) of the coal mine, qasification plant, and product pipeline receive limited recreational use, due to the lack of developed recreation resources and well-established access roads. Intermittent (seasonal) dispersed recreation activities such as hunting, fishing along the Platte River, ORV use, and sightseeing all occur within this area. In the larger (10-county) region, approximately 70 percent of the land surface is privately owned (compared to 42 percent statewide) (Water Resources Research Institute 1973). Consequently, local residents have less public land available for outdoor recreation than do residents in other parts of Wyoming, and access to this land is limited. The National Forests (Big Horn, Black Hills, and Medicine Bow), and Devils Tower National Monument, located on the periphery of the region, are among the major recreation attractions in the area. Reservoirs, the Platte River, and county parks are other major resources in the region. See Tables D-7 through D-15 in Appendix D for participation trends in major recreation resource areas.

The following is a discussion of recreation within the project region, organized by activity type, which directly relates to the major resource areas identified above.

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The following is a discussion of recreation within the project region, organized by activity type, which directly relates to the major resource areas identified above.

Hunting

Big-game hunting (primarily for antelope, white-tailed and mule deer, and elk) is a major recreation activity in the 10-county region. A summary of the total antelope harvest and estimates of the total number of deer and elk hunters for each of the 10 counties are shown in Tables D-17, D-18, and D-19 in Appendix D. Waterfowl hunting takes place on farm ponds and larger streams (such as the North Platte River) in the late fall and winter.

Fishing

In Wyoming, fishing is one of the most popular outdoor recreation activities, second only to picnicking. The participation estimate for fishing in 1979 was 50.3 percent of the state population (Wyoming Recreation Commission 1980). Due to the shortage of streams within the region and the lack of access to them, sport fishing generally takes place on the North Platte River and associated reservoirs. Of all the streams in Wyoming, the North Platte River has the highest resident use rate for fishing. For standing waters, the Pathfinder Reservoir has the highest resident use rate (Carlson and Phillips 1979). Rainbow, cutthroat, and brown trout are all taken, and brook trout are abundant in many tributary streams.

Winter Sports (Snowmobiling, Skiing)

Commercial downhill ski resorts in the region are Meadowlark (west of Buffalo), Hogadon (south of Casper), and Terry Peak (northeast of Newcastle). Cross-country skiing and snowmobiling opportunities are available in or adjacent to the Bighorn, Black Hills, and Medicine Bow National Forests, Keyhole State Park, and Beartrap Meadow County Park in the Muddy Mountain area. The Newcastle area has proven attractive to snowmobilers and cross-country skiers, and is becoming more popular with local residents and outsiders alike.

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Fishing

In Wyoming, fishing is one of the most popular outdoor recreation activities, second only to picnicking. The participation estimate for fishing in 1979 was 39.3 percent of the state population (Wyoming Recreation Commission [1980]). Due to the shortage of streams within the region and the lack of access to them, sport fishing generally takes place on the North Platte River and associated reservoirs. Of all the streams in Wyoming, the North Platte River has the highest resident use rate for fishing. For standing waters, the Pathfinder Reservoir has the highest resident use rate (Carlson and Phillips 1979). Rainbow, cutthroat, and brown trout are all taken, and brook trout are abundant in many tributary streams.

Winter Sports (Snowmobiling, Skiing)

Commercial downhill ski resorts in the region are Meadowlark (west of Moffatt), Sugadee (south of Casper), and Terry Peak (northeast of Newcastle). Cross-country skiing and snowmobiling opportunities are available in or adjacent to the Bighorn, Black Hills, and Medicine Bow National Forests, Keyhole State Park, and Beartrap Meadow County Park in the Muddy Mountain area. The Newcastle area has proven attractive to snowmobilers and cross-country skiers, and is becoming more popular with local residents and outsiders alike.

Boating/Swimming

Opportunities for boating and swimming in the region are limited, as in most semiarid regions. Water-based recreation is generally confined to the one major river (North Platte) and the region's lowland reservoirs. Glendo, Guernsey, Keyhole, Alcova, Pathfinder, Gray Reefs, and Seminoe are among the most frequently used water recreation resources in the area. These reservoirs were constructed by the U.S. Bureau of Reclamation. Glendo, Guernsey, Keyhole, and Seminoe are currently operated by the Wyoming Recreation Commission as state parks. The recreation areas at Alcova (3,237 acres), Pathfinder (800 acres), and Gray Reefs (143 acres) are county parks managed by the Natrona County Parks Board. Kortes recreation areas are managed by Wyoming Game and Fish (U.S. Bureau of Reclamation 1981).

The Platte River is extensively used for rafting, canoeing, and fishing in and around Casper, Glenrock, and Douglas. Local residents are the primary users of the river for recreation. Keyhole, Glendo, and Guernsey reservoirs offer good boating, water skiing, and swimming opportunities in spring and early summer. Drawdowns reduce the water levels and the recreation opportunities in late summer. Both the local public and traveling visitors use Alcova, Pathfinder, and Seminoe. Alcova has the highest resident use rate (for a reservoir) for power boating, canoeing, sailing, float-boating, water skiing, and swimming.

Camping/Picnicking/Hiking

Participation estimates for specific outdoor recreation activities by Wyoming residents for 1979 indicate that picnicking had the largest percentage of population participation at 74.4 percent. The second highest participation rate was for overnight camping with 55.3 percent. Most camping and picnicking takes place in the cooler forested or mountainous areas and near major water bodies in the region. Popular areas include the Bighorn, Black Hills, and Medicine Bow

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national forests, Devils Tower National Monument, the Keyhole, Glendo, and Guernsey state parks, the Alcova, Gray Reef, Kortes, and Pathfinder reservoirs. Smaller private and county owned picnic sites and campgrounds are also used by local residents and traveling visitors, especially in the Casper, Glenrock, and Douglas areas. For example, Campbell Creek Campground is located near LaPrele and has nine units. Curtis Gulch Campground is located in LaBonte Canyon in Medicine Bow National Forest, and contains six units. Muddy Mountain has two campgrounds, Lodgepole and Rim Overlook, both 15 miles from Casper. Casper Mountain provides skiing, hiking, hunting, fishing, and camping opportunities in varying degrees (due to private lands within the area). Most of the dispersed and developed recreational opportunities existing on Casper Mountain are inadequate for the present population adjacent to the area.

Hiking is also a popular outdoor recreational activity at almost all of the federal, state, and county parks.

Sightseeing/Historical/Interpretive

Wildlife (including big game, small mammals, raptors, songbirds, waterfowl, and game birds), geological formations (such as Devils Tower, Pumpkin Buttes, and the Rozet Escarpment), historic sites (Fort Fetterman, Fort Laramie), and trails (Oregon, Bozemen, Mormon, Stage Roads, and Pony Express routes) provide excellent sightseeing on or near major highways in the region. Federal, state, and local agencies and groups have developed visitor interpretive sites describing these various natural and cultural resources, several of which have been placed on the National Register of Historic Places. Recreation activities such as rock hounding and exploring for historic ruins are important sports in Wyoming. These activities frequently involve the use of ORVs to access out-of-the-way sites.

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ORV Use

Four-wheel drive vehicles are used as both recreational and family vehicles. ORV use may occur in conjunction with hunting, fishing, or sight-seeing, or simply on overland trails and dirt tracks. Much of the recreational use of four-wheel drive vehicles occurs in the Black Hills and Bighorn national forests. A major problem confronting ORV users is seeking access to public land where they can operate their vehicles. This frequently requires crossing private property which creates conflicts with individual landowners. Public lands that are accessible are currently suffering ORV damage in the form of soil compaction, erosion, and vegetation destruction.

2.10 VISUAL RESOURCES

Visual resources are the physical characteristics of a landscape that determine its scenic quality and relevant value to the viewing public. These characteristics are frequently described according to the line, form, color, and texture of the natural features in the environment (landform, vegetation, water, and soils) that make up a specific landscape scene. Since the term "scenic" implies exposure to human sensory experience, the visual resources of most importance to this assessment are those within the "seen-area" of both existing and potential human use areas (roadways, rivers, trails, recreation sites, and human developments). The focus of attention is on unique and high quality visual resources, such as mountainous terrain, steep slopes, natural waterways, open valleys, interesting patterns of vegetation, rock formations, and landscapes that create a particular visual image or mental picture (e.g., the badlands, grasslands).

The primary reference and method for identifying visual resources for this assessment was the BLM Visual Resource Management (VRM) system. The VRM system has been adopted by BLM to provide a standardized procedure for identifying, evaluating, and classifying visual resources for land management purposes.

The VRM system, described fully in BLM Manual Section 8400 (BLM 1978) uses three primary factors in determining compatibility of proposed developments with the existing natural landscape:

- the inherent quality of the landscape features (visual resources) being viewed
- the sensitivity of the visual resources according to public exposure and public concern for the scene

- the viewing distance of the resources from areas of human use and access.

Once inventoried for the above factors, each BLM planning area is divided into subunits which can be uniformly characterized and assigned a visual management classification. There are five possible VRM classification designations (described in Table 2.10-1) ranging from highly valued, pristine landscapes to areas where human modifications have already disturbed the natural setting to a point of needing rehabilitation.

Because a portion of the project (the mine and railroad) is on U.S. Forest Service property, a similar Visual Management System described in Agriculture Handbook 462 (U.S. Forest Service 1974) and developed for Forest Service use was the second primary reference for this study. The Forest Service inventories their public lands and classifies them according to character types, variety class, and sensitivity level, and develops Visual Quality Objectives (VQO) for each area. Table 2.10-2 defines the five management levels (VQO) that the Forest Service uses.

Table 2.10-3 summarizes the visual resource management classes developed by both the BLM and Forest Service for landscapes traversed by each of the proposed project components. The following discussion briefly describes the dominant visual features and overall visual character for each of these areas.

Mine

The proposed Rochelle Mine site, in the Thunder Basin National Grasslands under the management of the U.S. Forest Service, has been inventoried and given a VQO rating of 66 percent Maximum Modification, 23 percent Modification, and 11 percent Partial Retention. The land-

- the viewing distance of the resources from areas of human use and access.

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Mine

The proposed Rosebud Mine site, in the Thunder Basin National Grasslands under the management of the U.S. Forest Service, has been inventoried and given a VQO rating of 66 percent Maximum Modification, 23 percent Modification, and 11 percent Partial Retention. The land-

TABLE 2.10-1

VISUAL RESOURCE MANAGEMENT CLASSES FOR BUREAU OF LAND MANAGEMENT LANDS

Class I	-	This class primarily provides for natural ecological changes only. It is applied to primitive areas, some natural areas, and similar situations where management activities are to be restricted.
Class II	-	Changes in any of the basic elements (form, line, color, or texture) caused by a management activity should not be evident in the characteristic landscape.
Class III	-	Changes in the basic elements caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.
Class IV	-	Changes may subordinate the original composition and character but must reflect what could be a natural occurrence within the characteristic landscape.
Class V	-	This class applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation in which the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short-term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

Source: Bureau of Land Management 1978.

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Source: Bureau of Land Management 1978.

TABLE 2.10-2

VISUAL QUALITY OBJECTIVES FOR U.S. FOREST SERVICE LANDS

Reservation (P) --
A visual quality objective that provides for ecological changes only.

Retention (R) --
In general this VQO means that human activities should not be evident to the casual forest visitor.

Partial Retention (PR) --
Human activities may be evident but must remain subordinate to the characteristic landscape.

Modification (M) --
Human activities may dominate the characteristic landscape but must, at the same time utilize naturally established form, line, color, and texture. Development should appear as a natural occurrence when viewed in the foreground or middleground.

Maximum Modification (MM) --
Human activity may dominate the characteristic landscape but should appear as a natural occurrence when viewed as background.

Source: U.S. Forest Service 1974.

TABLE 2.10-3

VISUAL RESOURCE INVENTORY CLASSES AND MANAGEMENT OBJECTIVES FOR LANDSCAPES OCCUPIED BY PROJECT COMPONENTS (by percent)

Project Component	Visual Quality/ Variety Class	Sensitivity	Management Objective
COAL MINE	11% A[a] 11% B[a] 78% C[a]	90% Low 10% Average	11% PR[c] 23% M[c] 66% MM[c]
RAILROAD	24% A[b] 9% B[b] 67% C[b]	29% Low 71% Average	24% PR[c] 71% M[c] 5% MM[c]
PLANT	100% C[b]	100% Medium	100% IV[d]
WATER SYSTEMS			
North Well Field	100% C[b]	20% Medium 80% Low	100% IV[d]
South Well Field	20% B[b] 80% C[b]	80% High 20% Low	15% II[d] 65% III[d] 20% IV[d]
LaPrele Reservoir	100% B[b]	98% High 2% Low	98% II[d] 2% IV[d]
Water Pipeline	5% A[b] 95% C[b]	30% High 20% Medium 50% Low	10% II[d] 15% III[d] 75% IV[d]
Combs Reservoir	100% C[b]	100% Low	40% III[d] 60% IV[d]

[a]A - Distinctive features
B - Common features
C - Minimal features

[b]A - Outstanding characteristics
B - Combination of outstanding and common features
C - Features fairly common to physiographic area

[c]Defined in Table 2.10-2.
[d]Defined in Table 2.10-1.

TABLE 2.10-3

VISUAL RESOURCE INVENTORY CLASSES AND MANAGEMENT OBJECTIVES
FOR LANDSCAPES OCCURRING WI PROJECT COMPONENTS (by percent)

Project Component	Visual Quality/ Variety Class	Sensitivity	Management Objective
COAL MINE	11% A[a] 11% B[a] 78% C[a]	80% Low 10% Average	11% VR[c] 11% M[c] 68% MR[c]
RAILROAD	34% A[a] 3% B[a] 63% C[a]	29% Low 71% Average	24% PR[c] 71% M[c] 5% MR[c]
PLANT	100% C[a]	100% Medium	100% IV[d]
WATER SYSTEMS			
North Well Field	100% C[b]	20% Medium 80% Low	100% IV[d]
South Well Field	10% A[b] 90% C[b]	80% High 20% Low	12% II[d] 88% III[d] 20% IV[d]
Lafrate Reservoir	100% B[b]	98% High 2% Low	98% II[d] 2% IV[d]
Water Pipeline	2% A[b] 98% C[b]	30% High 20% Medium 50% Low	10% II[d] 18% III[d] 72% IV[d]
Combs Reservoir	100% C[b]	100% Low	80% III[d] 80% IV[d]

[a] A - Distinctive features
B - Common features
C - Minimal features.

[b] A - Outstanding characteristics
B - Combinations of outstanding and common features
C - Features fairly common to physiographic area

[c] Defined in Table 2.10-2.
[d] Defined in Table 2.10-1.

scape is generally characterized by slopes ranging from 5 to 20 degrees; fair to poor vegetation cover; severe sheet and rill erosion with locally severe gully erosion. The northwest portion of the mine site is a flat, treeless plateau; the southern and eastern portions are rugged, barren badlands. The combination of the results of natural erosion processes and topographical irregularities of burned coal areas has created some interesting visual lines and patterns which are accentuated with light, shadow, and coloration of soil layering.

The two areas of highest visual quality (variety class "A") exhibit visual dominance of moderate to steep slopes, and exposed coal seams that have burned and resulted in a rich, red soil coloration (this is referred to as scoria). These areas also contain the greatest variety of vegetation texture and colors; ranging from soft muted colors of low grasses and brush, to the dark green clusters of the ponderosa pine stands. Though these areas have a high visual quality classification, they have a low sensitivity rating. The reason for the low sensitivity is: limited access to the area (thus it is seldom "seen" by the viewing public), and both existing and proposed coal mines have influenced the visual quality potential for the area.

Railroad

The portion of landscape traversed by the railroad within the Thunder Basin National Grasslands, and the area immediately south of the grasslands, has been inventoried and given a VQO rating of 71 percent Modification and 24 percent Partial Retention. The areas with the higher rating exhibit characteristics similar to those described above for the mine site. The visual quality (variety class) has been evaluated high ("A") because of topographic features, scoria and resultant rich colors, and soil patterns. Public access to these areas, however, is extremely limited.

The remainder of the rail corridor traverses landscapes of lower visual quality ("C") and higher sensitivity. These areas are characterized by flat, open plains with little vegetation and little to no distinctive visual features. The existence of a major roadway (Highway 59) accounts for the high visibility and the fact that the natural character of the landscape has already been modified.

Plant

The BLM has inventoried the visual resources on the land-scape where the proposed plant would be built and has determined that the management class is IV (allowing a contrast to attract attention and become a dominant feature in terms of scale, as long as it attempts to repeat the line, form, and color of the natural setting). The existing landscape is a flat, open plain with panoramic vistas, but offers no distinctive visual feature. This landscape is common to the physiographic region. The proximity to Highway 59 makes this set-ting high in visibility, but the common nature of the visual resources reduces the sensitivity rating and public interest in preservation.

North Well Field

The North Well Field is a VRM management class IV (allowing visual features to be introduced that blend with the natural line, form, color, and texture of the landscape setting). Because of limited access to this area and its rather common features, the landscape has a medium sensitivity and a low visual quality rating.

The terrain in this area is flat to gently rolling topography, drained primarily by Little Lightning Creek. One of the dominant features of the landscape is the line and form created by the divide extending southeast across the southern portion of the site where the North Platte and Cheyenne rivers divide. Vegetation is sparse and

primarily limited to grasses, except along the creek bed where some riparian growth persists.

South Well Field

Visual resources for the South Well Field area have been classified by BLM as follows: approximately 15 percent of the landscape is VRM II, 65 percent is III, and the remaining 20 percent is IV. The Class II portions include the drainage areas of Little Box Elder Creek in the northeast and southwest sections of the well field. The southwest section, in particular, exhibits visually interesting lines and forms resulting from the downcutting and relief from the creek drainage patterns. This portion also borders Converse County Park, giving the landscape higher sensitivity to public view.

Combs Reservoir

Combs Reservoir is rated a VRM Class III for 40% of the area and VRM Class IV for the remaining area to be occupied by the proposed reservoir. The landscape lacks dominant visual features of note and has low sensitivity.

LaPrele Reservoir

LaPrele Reservoir, framed on the north by a mountain range, sandstone outcroppings, and sparse clusters of vegetation, is rated 98% VRM II and 26 Class IV. Access to the reservoir is limited to a county road at the southern end. Ayres Natural Bridge Park is located immediately over the ridge to the north of the reservoir, however the reservoir is outside the "seen area" of the park.

2.11 LAND USE

With the exception of the expanding development of mineral resources, the 8.9 million acres of land comprising Campbell, Converse, Laramie, and Platte counties are devoted almost entirely to agriculture, chiefly in the form of nonirrigated rangeland. Approximately 85 percent of this rangeland is privately owned.

Over 99 percent of the lands to be affected by project activities can be classified as agricultural (i.e., rangeland, pastureland, and irrigated and non-irrigated cropland). The remaining lands in the project area can be classified as mixed-urban or built-up lands.

Agriculture

Agricultural land use and productivity in the project area are presented in Table 2.11-1. Approximately 93 percent of the project site consists of non-irrigated rangeland (primarily prairie grassland) used for livestock grazing. Approximately 6 percent of the site has been developed into pastureland. Less than 1 percent of the project site is used for cropland (irrigated and nonirrigated).

A total of 16 ranches operate in the project area (Tables 2.11-2 and 2.11-3). These ranches rely on public rangeland, as well as private lands, to maintain economically viable operations. The public lands are grazed either seasonally or year-long under range management programs administered by the BLM and U.S. Forest Service. Under an agreement with the Natural Resources Defense Council, the BLM is in the process of incorporating the preparation of site-specific environmental impact statements (EIS) and allotment management plans into its grazing program. The EISs will describe planned actions to improve the rangelands under BLM jurisdiction for grazing, wildlife habitat, watershed protection, and other uses. The U.S. Forest Service has

TABLE 2.11-1

AGRICULTURAL LAND USE AND PRODUCTIVITY IN THE PROJECT AREA

Project Component	Land Use	Approx. Acreage	Animal or Crop[a]	Productivity[b] Per Acre
Rochelle Mine	Rangeland	6,550	cattle	0.05 to 0.33 AUM[c]
			sheep	0.25 to 1.65 AUM
Railroad	Pastureland	32	cattle	0.5 AUM
			sheep	2.5 AUM
	Rangeland	1,006	cattle	0.2 AUM
			sheep	1.0 AUM
Gasification Plant	Pastureland	310	cattle	0.5 AUM
			sheep	2.5 AUM
	Rangeland	3,372	cattle	0.2 AUM
			sheep	1.0 AUM
Combs Reservoir	Rangeland	820	cattle	0.2 AUM
			sheep	1.0 AUM
North Well Field	Rangeland	20,840	cattle	0.2 AUM
			sheep	1.0 AUM
South Well Field	Irrigated Cropland	798	barley	31 bu.
			spring or winter wheat	34 bu.
			oats	46 bu.
			beans	0.76 t.
			corn	90 bu.
	Pastureland	872	cattle	0.5 AUM
			sheep	2.5 AUM
	Rangeland	20,809	cattle	0.2 AUM
			sheep	1.0 AUM
Water Pipeline	Irrigated Cropland	22	barley	31 bu.
			spring or winter wheat	34 bu.
			oats	46 bu.
			beans	0.76 t.
			corn	90 bu.
	Rangeland	133	cattle	0.2 AUM
			sheep	1.0 AUM
	Pastureland	4	cattle	0.5 AUM
			sheep	2.5 AUM
Product Pipeline	Nonirrigated Cropland	284	winter wheat	19-23 bu.
			barley	14-25 bu.
			oats	15-21 bu.
			hay	0.75-1.2 t.
	Pastureland	92	cattle	0.5-1.0 AUM
			sheep	2.5-5.0 AUM
	Rangeland	1,586	cattle	0.2-0.3 AUM
			sheep	1.0-1.5 AUM

Sources: SCS 1978 a, b, c, d; Carroll et al. 1979; Econ Inc. 1980 .

[a]For each use, current animal or crop may be one or more of those listed.
[b]Grazing productivity figures for all components except mine are based on SCS recommendations with good management. Figures for mine are based on data collected by Econ Inc. (1980). Crop yields are from Wyoming Agricultural Statistics.
[c]AUM = Animal Unit Months of grazing.

TABLE 7.3[1-1]

AGRICULTURAL LAND USE AND PRODUCTIVITY IN THE PROJECT AREA

Project Component	Land Use	Approx. Acreage	Animal or Crop*	Productivity[a] + Per Area
Rochelle Weir	Rangeland	6,320	cattle	0.05 to 0.17 AUM
			sheep	0.25 to 1.25 AUM
Railroad	Farmrelated	72	cattle	0.1 AUM
			sheep	1.1 AUM
	Rangeland	1,450	cattle	0.1 AUM
			sheep	1.0 AUM
Desilting Weir Plan	Farmrelated	320	cattle	0.1 AUM
			sheep	1.7 AUM
	Rangeland	3,372	cattle	0.1 AUM
			sheep	1.0 AUM
Combs Reservoir	Rangeland	800	cattle	0.1 AUM
			sheep	1.0 AUM
North West Plain	Rangeland	30,000	cattle	0.1 AUM
			sheep	1.0 AUM
South West Plain	Irrigated Cropland	120	barley	32 bu.
			wheat	32 bu.
			corn (grain)	60 bu.
			corn (silage)	0.15 t.
			oats	80 bu.
	Farmrelated	870	cattle	0.1 AUM
			sheep	1.1 AUM
	Rangeland	30,400	cattle	0.1 AUM
			sheep	1.0 AUM
Weiss Pipeline	Irrigated Cropland	12	barley	32 bu.
			wheat	32 bu.
			corn (grain)	60 bu.
			corn (silage)	0.15 t.
			oats	80 bu.
	Farmrelated	320	cattle	0.1 AUM
			sheep	1.1 AUM
	Rangeland	1,400	cattle	0.1 AUM
			sheep	1.0 AUM
	Farmrelated	4	cattle	0.1 AUM
			sheep	1.1 AUM
Proposed Pipeline	Residential-Cropland	120	winter wheat	12-22 bu.
			barley	14-25 bu.
			corn	13-21 bu.
			hay	0.22-1.5 t.
	Farmrelated	40	cattle	0.3-1.8 AUM
			sheep	2.7-3.0 AUM
	Rangeland	1,320	cattle	0.2-0.3 AUM
			sheep	1.0-1.2 AUM

Sources: SCS 1978 a, b, c, d; Zavaski et al. 1972; Ross Inc. 1980.

[a]For each use, numerical values in each may be one or more of values listed.
Grazing productivity figures for all conservation storage sites are based on SCS information with good management. Figures for sites are based on data collected by Ross Inc. (1980). Crop yields are from Wyoming Agricultural Statistics.

*AUM = Animal Unit Months of grazing.

TABLE 2.11-2

BLM LIVESTOCK GRAZING ALLOTMENTS IN THE PROJECT AREA

Project Component	Grazing Allotment/ Operator	Season of Use	Condition of Range
Railroad	Henry Cheesborough	Spring	Good
	Jake Johnson	Winter	Good
Plant	None	-	-
Combs Reservoir	None	-	-
North and South Well Fields	None	-	-
Water Pipeline	Mortons, Inc.	Summer	Good
Product Pipeline	Buffalo Pool	Summer	Good
	Vernon Bomgartner	Summer/Fall	Fair to Good
	Ruth Frederick	Summer	Fair
	Alvin Reffalt	Summer	Good
	Walter Johnson	Summer	Fair
	Orr Cattle Co.	Summer	Good
	Florence Eddy	Summer/Fall	Fair

Source: Bureau of Land Management 1981a.

TABLE 2.11-3

FOREST SERVICE LIVESTOCK GRAZING ALLOTMENTS IN THE PROJECT AREA

Grazing Allotment[a] Number	Operator	Season of Use	Condition of Range
255	Stoddard Ranches	Summer/Fall	Fair
253	Ernest Steinle Estate	Spring/Summer	Fair
231	Morton, Inc.	Summer/Fall	Fair
235	Lincoln Pellatz	Summer/Fall	Fair
237	Donald Pellatz	Summer/Fall	Fair
231	Morton, Inc.	Summer/Fall	Good
205	John Dilt	Year Long	Good

[a]All Forest Service grazing allotments are located along the railroad corridor.

Source: U.S. Forest Service 1981.

also initiated a new management program to improve rangeland quality and increase productivity on lands it administers.

In 1979, roughly 275,000 cattle and 210,000 sheep were grazed on rangeland in Converse, Campbell, Platte, and Laramie counties (Wyoming Crop and Livestock Reporting Service 1980). Many livestock operations have been shifting from sheep to cattle in recent years for market reasons. Other classes of livestock contribute little to total regional production (BLM 1976).

Eastern Wyoming is not noted for extensive farming activities. Hay, the major crop in the region, is used primarily by local livestock operations. Most of the hay is produced on irrigated meadows near available water supplies such as the North Platte and Laramie rivers, and to a lesser extent on dryland farms in Campbell County. In 1978, approximately 175,000 acres in Converse, Campbell, Platte, and Laramie counties were used for irrigated and non-irrigated hay production (Wyoming Crop and Livestock Reporting Service 1979).

Dryland farming acreages, crop yields, and success rates in eastern Wyoming vary from year to year because of market fluctuations and weather conditions. During the past four decades, total dryland farming acreage has decreased as submarginal lands have been retired from cultivation and put to livestock grazing. Recently, however, some of these lands have again been placed into crop production in response to government farm programs and increases in grain prices (BLM 1979). In 1978, approximately 250,000 acres were under cultivation for crops such as wheat, barley, oats, beans, and corn in Converse, Campbell, Platte, and Laramie counties (Wyoming Crop and Livestock Reporting Service 1979).

The lease boundary for the proposed plant encompasses 310 acres of pastureland and 3,372 acres of rangeland. The proposed facilities themselves, will occupy 815 acres of rangeland. Livestock on the unaffected 2,867 acres will be allowed to continue.

The approximate ground cover on range sites similar to the plant site is 15 to 25 percent. Suggested initial stocking rates for these range sites are 0.2 AUMs/acre on ranges in excellent condition, 0.17 AUMs/acre on good sites, 0.10 AUMs/acre on fair sites, and 0.05 AUMs/acre on poor range sites (SCS 1977). According to the SCS (1981) this range presently supports 0.2 AUMs/acre.

The proposed mine is located on 6,550 acres of rangeland. It is estimated that the mine site has a livestock carrying capacity of 0.05 to 0.33 AUMs/acre (Econ Inc. 1980). The prairie grassland vegetation (2,358 acres) has the highest carrying capacity at 0.33 AUMs/acre. The breaks type, including areas with pine cover (2,844 acres), has an average carrying capacity of 0.10 AUMs/acre. Scoria vegetation (1,348 acres) supports only 0.05 AUMs/acre.

The proposed railroad corridor will pass through 1,006 acres of rangeland and 32 acres of pastureland (assuming a 200 foot right-of-way). South of the Thunder Basin National Grasslands the route will traverse privately owned lands. North of this area, the route will dissect (from south to north) U.S. Forest Service grazing allotments 255, 253, 231, 235, 237, 231, and 205 (Table 2.11-3).

The 32 acres of pastureland which will be traversed by the railroad is used primarily for dry production of cultivated pasture species (Ecology Consultants, Inc. 1975). The Missouri River Basin Commission (1959) estimated range carrying capacity for several isolated tracts near the proposed railroad corridor and reported

estimates from 0.05 to 0.25 AUMs/acre. According to the SCS (1981) this area supports 0.2 AUMs/acre.

The product pipeline corridor will traverse 1,586 acres of rangeland, 92 acres of pastureland, and 284 acres of nonirrigated cropland. Most of the corridor lies in the area where prairie grassland vegetation (rangeland) supports 0.3 AUMs/acre of livestock grazing. A smaller portion of the route through Converse and northern Platte counties (roughly from MP 0 to Cedar Top Butte and Sheep Mountain), is in the 10"-14" Northern Plains Precipitation Zone; these grasslands support approximately 0.2 AUMs/acre.

The grazing capacity is higher on pastureland than rangeland, primarily as a result of the introduction of exotic species (e.g., crested wheatgrass) which provides more forage per acre. Productivity of pastureland in this portion of Wyoming varies between 0.5 and 1.0 AUMs/acre.

The majority of the cultivated agricultural lands that will be traversed by the product pipeline are used for winter wheat production. Many of these winter wheat fields are also grazed.

Agricultural lands affected by components of the water supply system include rangeland, pastureland, and irrigated croplands. The North Well Field is primarily rangeland used for cattle and sheep grazing. The Missouri River Basin Commission (1959) estimated grazing capacity for several tracts within or immediately adjacent to that well field. Estimates ranged from 0.18 to 0.33 AUMs/acre. Presently, the area supports about 0.2 AUMs/acre.

Mineral Resources

Eastern Wyoming is rich in mineral resources, and potentially economic mineral deposits are reported to be present in many of the geologic units on which proposed project components would be constructed. The following discussion is limited to those mineral deposits that would be directly affected by the project.

The proposed plant site is underlain by coal deposits that are not considered strippable (USGS 1974) and by oil and gas-bearing strata. Comparison of Wyoming Geological Survey maps prepared by Glass et al. (1975) and more recently by Ver Ploeg et al. (1980) shows that the known extent of oil and gas deposits in the vicinity of the site has grown rapidly, as several individually named fields have been found to be part of a single larger field. The fields near the proposed plant site are Well Draw, Don Draw, and Mikes Draw. Table 2.11-4 is a summary of individual oil and gas fields in the vicinity of the proposed project components, showing production and estimated reserves as of 1978.

On the plant site property there are at least six producing oil and gas wells, one of which would lie within the area of facilities construction. However, based on the reportedly high depletion rate for wells in this area, this well is expected to be nearing the end of its productive life by the start of plant construction (WyCoalGas 1981).

The proposed railroad would cross coal-bearing strata (Glass et al. 1975) considered not strippable (USGS 1974). The route would probably cross deposits of clinker, a baked clay produced by the spontaneous combustion of coal (Coates 1978). Railroads in the general area have made extensive use of clinker for ballast, and clinker has been used for construction of low-traffic roads (Breckenridge et al. 1974).

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The proposed plant site is underlain by coal deposits that are not considered strippable (WSGS 1974) and by oil and gas-bearing strata. Comparison of Wyoming Geological Survey maps prepared by Glass et al. (1975) and more recently by Van Fleet et al. (1980) shows that the known extent of oil and gas deposits in the vicinity of the site has grown rapidly, as several individually named fields have been found to be part of a single larger field. The fields near the proposed plant site are Well Draw, Dun Draw, and Skiles Draw. Table 3.11-4 is a summary of individual oil and gas fields in the vicinity of the proposed project components, showing production and estimated reserves as of 1978.

On the plant site property there are at least six producing oil and gas wells, one of which would lie within the area of facilities construction. However, based on the reportedly high depletion rate for wells in this area, this well is expected to be nearing the end of its productive life by the start of plant construction (Wyoming Oil 1981).

The proposed railroad would cross coal-bearing strata (Glass et al. 1975) considered not strippable (WSGS 1974). The route would probably cross deposits of clinker, a baked clay produced by the spontaneous combustion of coal (Gratton 1978). Railroads in the general area have made extensive use of clinker for ballast, and clinker has been used for construction of low-traffic roads (Hinchcliffe et al. 1974).

TABLE 2.11-4

OIL AND GAS FIELDS IN THE VICINITY OF THE PROPOSED PROJECT

Field	Number of Wells	Cumulative Production		Reserves		Project Components
		Oil (bbl)	Gas (mcf)[a]	Oil (bbl)	Gas (mcf)[a]	
Well Draw	291	12,342,558	21,689,648	8,500,000	14,000,000	Plant
Don Draw	11	621,444	522,821	753,566	633,423	Plant, Railroad
Mikes Draw	40	1,400,630	853,438	3,599,370	2,192,562	Plant, Railroad
Steinle Ranch	14	2,809,914	3,675,436	1,250,000	1,500,000	Railroad
Harvey Draw	1	2,638	3,426	0	0	N. Well Field
Brenning Basin	50	7,052	0	0	0	S. Well Field
Flat Top	41	1,982,723	20,561,043	550,000	5,000,000	Product Pipeline

Source: Barlow and Haun 1978.

[a]mcf = thousand cubic feet.

TABLE 2.11-4

OIL AND GAS FIELDS IN THE VICINITY OF THE PROPOSED PROJECT

Field	Number of Wells	Cumulative Production: Oil (bbl)	Cumulative Production: Gas (mcf)[a]	Reserve: Oil (bbl)	Reserve: Gas (mcf)[a]	Project Components
Well Draw	291	12,342,358	31,457,643	8,500,000	14,000,000	Plant
Don Draw	11	621,444	322,821	723,566	623,423	Plant, Railroad
Miles Draw	40	1,400,630	853,438	3,399,370	2,103,562	Plant, Railroad
Stelcle Ranch	14	2,020,916	3,075,436	1,250,000	1,500,000	Railroad
Harvey Draw	1	2,038	3,438	0	0	R. Well Field
Browning Basin	50	7,072	0	0	0	S. Well Field
Flat Top	41	1,823,723	20,361,043	550,000	5,000,000	Product Pipeline

Source: Barlow and Haun 1978.

[a]mcf = thousand cubic feet.

Billions of cubic yards of this material are said to be available in the northeastern Wyoming coal fields (Clabaugh et al. 1946; Dobbin and Barnett 1928). The railroad would use clinker for subballast and probably crushed rock for ballast. The Guernsey Stone Company quarry has been producing siliceous dolomite and diabase for this type of use for many years; this quarry, located near Guernsey, also is a possible source of rip-rap for the proposed Combs Reservoir.

The area that would be traversed by the railroad has many producing oil and gas wells, some of which may lie outside of fields most recently identified by the Wyoming Geological Survey (Ver Ploeg et al. 1980). The railroad would cross the Mikes Draw/Don Draw field between MP 0 and 15, and the Steinle Ranch field approximately between MP 26 and 27. These fields were discovered between 1972 and 1974; available production and reserves data are shown in Table 2.11-4.

The proposed Combs Reservoir, sections of the proposed water pipelines, and part of the proposed South Well Field are underlain by belts of coal outcrop, as mapped by Shaw (1909). Mining in this general area started in 1887, but only two mines remained in operation by 1907 (Shaw 1909); both of these mines are well to the east of the proposed facilities. The northern boundary of the South Well Field adjoins a group of abandoned mines (Hausel et al. 1979) that probably date from the early 1900s. The proposed North Well Field is underlain by unstrippable coal deposits (Hausel et al. 1979, U.S. Geological Survey 1974).

The North Well Field would encompass the Harvey Draw oil field (Ver Ploeg et al. 1980), a small field discovered in 1975. Production figures for this field are provided in Table 2.11-4; the reserves were judged to be nil in 1978 (Barlow and Haun 1978).

billions of cubic yards of this material are said to be available in the northeastern Wyoming coal fields (Glabough et al. 1976; Dobbin and Barnett 1928). The railroad would use either for ballast and probably crushed rock for ballast. The Guernsey Stone Company quarry has been producing silicious dolomite and flakes for this type of use for many years; this quarry, located near Guernsey, also is a possible source of rip-rap for the proposed Combs Reservoir.

The area that would be traversed by the railroad has many producing oil and gas wells, some of which may be outside of fields were recently identified by the Wyoming Geological Survey (Ver Ploeg et al. 1980). The railroad would cross the Hiawatha Draw/Dan Draw field between MP 0 and 13, and the Stebbins Ranch field approximately between MP 26 and 27. These fields were discovered between 1972 and 1974; available production and reserves data are shown in Table 2.11-4.

The proposed Combs Reservoir, sections of the proposed water pipelines, and part of the proposed South Hall Field are underlain by beds of coal outcrop, as mapped by Shaw (1909). Mining in this general area started in 1887, but only two mines remained in operation by 1907 (Shaw 1909); both of these mines are well to the east of the proposed facilities. The southern boundary of the South Hall Field adjoins a group of abandoned mines (Hassel et al. 1979) that probably date from the early 1900s. The proposed Hall Field is underlain by unexploitable coal deposits (Lowell et al. 1979, U.S. Geological Survey 1974).

The North Hall Field would encompass the Harvey Draw oil field (Ver Ploeg et al. 1980), a small field discovered in 1975. Production figures for this field are provided in Table 2.11-4; the reserves were judged to be nil in 1978 (Harlow and Zann 1978).

The proposed South Well Field would encompass the Brenning Basin oil field (Ver Ploeg et al. 1980). This field has been inactive for many years; its total production was only 7,052 barrels of oil (Table 2.11-4).

A USGS investigation of sand and gravel resources in Wyoming shows extensive deposits in the North Platte River valley, adjacent to the proposed Combs Reservoir site (Larrabee and Shride 1946). Birch (1955) reported a "plentiful supply of gravel in all localities as of 1954," and went on to say that "almost every city and town in the state is either underlain by or situated near deposits of sand and gravel suitable for building."

The entire segment of the proposed product pipeline north in the Hartville Hills will traverse the Lost Spring coal field, as described by Winchester (1912). Numerous coal beds, most less than 3 feet thick, are reported to be present in the Fort Union Formation in this area. No known underground mines or beds mapped as potentially valuable for underground mining will be crossed (Winchester 1912). The USGS (1974) does not classify the coal beds in most of this region as strippable.

The Flat Top oil and gas field, located northwest of Shawnee and within the boundaries of the Lost Spring coal field, will be crossed by the proposed product pipeline from about MP 10 to 16. The reported cumulative production, since discovery in 1961, and estimated reserves for this field are presented in Table 2.11-4.

The proposed pipeline will cross extensive limestone deposits in the Hartville Hills. An early USGS report (Smith 1903) stated that the Guernsey and Hartville formations offer a practically inexhaustible supply of limestone. A subsequent USGS report on the construction mineral resources of Wyoming (Clabaugh et al. 1946) states that

limestone is plentiful and that future production can be increased to meet any industrial and construction needs. The total production of limestone in Wyoming during 1977 was reported to be 1.1 million tons (Geological Survey of Wyoming 1978). There appears to be only one active quarry in the vicinity of the product pipeline at the present time (Minobras 1975). This quarry is located west of the proposed right-of-way near Guernsey.

The product pipeline would cross an area of numerous or widespread iron deposits near Sunrise (Hausel et al. 1979, U.S. Geological Survey 1964), which have been mined almost continuously since 1898 (Root 1977). The ore is principally a red hematite, although other varieties of hematite are present. The principal sources have been the Sunrise, Good Fortune, and Chicago mines. The Good Fortune mine evidently operated only during 1953 and 1954 (Osterwald et al. 1966). The Hartville District produced hematite at a rate of 134,000 to 750,000 tons annually between 1898 and 1966, with most of the production going to the Colorado Fuel and Iron Co. plant at Pueblo, Colorado (Harrer 1966). The iron ore reserves at the Sunrise Mine as of 1978 were estimated to be 23 million tons (Wyoming Geological Survey 1978). Operations at this mine were shut down in 1980 (Goodier et al. 1981).

The proposed product pipeline would cross extensive deposits of sand and gravel in Whalen Canyon and in the North Platte River and Laramie River valleys (Larrabee and Shride 1946). The nearest reported gravel pit is about 1 mile west of the proposed route, in the vicinity of Guernsey. There appear to be no other pits in the above-described deposits, although there are a number of mapped pits west of the proposed route, near Cheyenne (Hausel et al. 1979). The total sand and gravel production for the state was reported to be 1.4 million tons in 1977 (Geological Survey of Wyoming 1978).

2.12 Cultural Resources

Proposed Action

A. General Description and Location of Major Project Components

3. Studies and Monitoring

WyCoalGas will conduct inventories and evaluations of cultural resources pursuant to their letter of June 26, 1981 (see Appendix E). These measures have been designed to minimize impacts to cultural resources by either avoiding or mitigating significant sites as required, through consultation with the State Historic Preservation Officer and Advisory Council on Historic Preservation.

2.~~11~~12.A.1 - Affected Environment

Cultural Resources

Prehistory

General Introduction

a. A detailed synthesis of the prehistory of the region through which the proposed action and alternate railroad route would pass is provided in the Class I Prehistoric Cultural Resource Inventory for the WyCoalGas Project (Larson-Tibesar 1981) available from the Bureau of Land Management, EIS team, State Office, Cheyenne, Wyoming. This synthesis includes cultural sequences through time and discussions of previous inventories within the project areas and buffer zones.

b. The proposed WyCoalGas Project is within the Northwestern Plains subarea of the Great Plains cultural area (Wedel 1961). Prehistoric cultural resources for this study are discussed by individual project components.

c.(1) Prehistoric site types within the proposed project areas are quite varied both because of changing environments from project component to project component and because "site type" descriptions in the past have not been uniform. Sensitive areas for prehistoric resources are those areas likely to contain sites that may be affected by the project. Sensitive areas are identified for the proposed action and railroad alternative.

c.(2) The eligibility status of any sites discussed in this section is that suggested by the original investigators'. Additional documentation will be required on any of these sites that are submitted for an eligibility determination.

2.12.A.2. - Affected Environment

Cultural Resources

Prehistory

Rochelle Mine and Buffer Zone

Four prehistoric sites have been recorded within the proposed mine area and thirteen sites have been recorded in the 1-mile buffer zone. Three of the sites within the mine area are described as not eligible for the National Register of Historic Places and the other site is considered potentially eligible for nomination. Of the thirteen sites in the buffer zone, six are listed as not eligible for nomination to the National Register of Historic Places and the remaining seven are considered potentially eligible. No prehistoric sites in either the mine area or the buffer zone are currently enrolled on the National Register.

The entire mine area should be considered a sensitive area. This is because it lies in a contact zone between a playa lake area, the Rochelle Hills, and the terraces of Porcupine Creek. Environmental contact zones such as the mine area have consistently yielded high prehistoric site densities. Large camp sites, small stone circle or tipi ring sites, and small lithic scatters are the predominant site types in the mine area and buffer zone.

2.~~11~~12.A.3. - Affected Environment

Cultural Resources

Prehistory

Railroad

Twelve prehistoric sites are known within the 1-mile wide corridor investigated for the Class I Prehistoric Inventory (Larson-Tibesar 1981). Of these, four also fall into the buffer zone for the mine and are discussed in that section. Of the remaining eight sites, one is known to be within the 200-foot wide impact area and is potentially eligible for nomination. The remaining seven fall within the 1-mile wide corridor but are not within the 200-foot wide impact area. Three of these seven sites are described as not eligible for nomination to the National Register of Historic Places and four are potentially eligible. No prehistoric sites in the railroad corridor are enrolled on the National Register of Historic Places.

Sensitive areas along the railroad corridor are considered major stream crossings and associated terraces, contact zones between big sagebrush grasslands and scoria grasslands, and playa lakebed areas. Stone circles and small lithic scatters are the predominant site types within the railroad corridor.

2.3.A.3. - Affected Environment

Cultural Resources

Prehistory

Railroad

Twelve prehistoric sites are known within the 1-mile wide corridor investigated for the Class I Prehistoric Inventory (Larson-Tibesar 1981). Of these, four also fall into the buffer zone for the mine and are discussed in that section. Of the remaining eight sites, one is known to be within the 200-foot wide impact area and is potentially eligible for nomination. The remaining seven fall within the 1-mile wide corridor but are not within the 200-foot wide impact area. Three of these seven sites are described as not eligible for nomination to the National Register of Historic Places and four are potentially eligible. No prehistoric sites in the railroad corridor are enrolled on the National Register of Historic Places.

Sensitive areas along the railroad corridor are considered major stream drainage and associated terraces, contact zones between big sagebrush grasslands and sagebrush grasslands, and playa lakebed areas. Stone circles and small lithic scatters are the predominant site types within the railroad corridor.

2.~~11~~12.A.4. - Affected Environment

Cultural Resources

Prehistory

Alternate Railroad Route

One prehistoric site is known to exist within the 1-mile wide corridor of the alternate railroad route. The site is described as a large camp site not eligible for nomination to the National Register of Historic Places. The site is within the 200-foot wide impact area of the alternate.

Sensitive areas along the alternate railroad corridor are considered major stream crossings and associated terraces, contact zones between big sagebrush grasslands and scoria grasslands, and playa lakebed areas. No prehistoric sites are currently enrolled on the National Register of Historic Places in the area of the alternate route.

2.~~11~~12.A.5. - Affected Environment

Cultural Resources

Prehistory

Plant Site and Buffer Zone

Three prehistoric sites are known for the plant site and 1-mile buffer zone. Two of these sites also fall within the Pipeline project areas and are discussed in that section. (One of these is described as not eligible for nomination to the National Register of Historic Places while the eligibility of the other is unknown). The remaining site is a small lithic scatter described as not eligible for nomination to the National Register of Historic Places. All of these sites may be impacted by construction within the plant site area. Sensitive areas within the plant site and buffer zone are believed to be drainage cuts and the edges of these features. No prehistoric sites are enrolled on the National Register of Historic Places from the proposed plant site area.

2.~~11~~12.A.6. - Affected Environment

Cultural Resources

Prehistory

WATER PROJECTS - reservoir, well fields, pipelines

Two prehistoric sites have been recorded within the reservoir's projected impact area. These sites are small lithic scatters described as not eligible for nomination to the National Register of Historic Places.

Four prehistoric sites are recorded within the Morton Well field. These are all open campsites of unknown National Register eligibility. One prehistoric site has been recorded within the Green Valley Area field. This site is described as a large cave site with pictographs. This site is potentially eligible for nomination to the National Register of Historic Places. No sites are recorded within the water pipeline corridor.

Sensitive areas for the water projects are small drainage cuts and associated drainage edges, the terraces of the North Platte River, and the La Prele Creek drainage. No sites are currently enrolled on the National Register of Historic Places from the water project areas.

2.~~11~~12.A.7. - Affected Environment

Cultural Resources

Prehistory

Gas Pipeline

Seventeen prehistoric sites are known to exist within the 1-mile wide corridor for the gas pipeline. Five of these sites are described as not eligible for nomination to the National Register of Historic Places and the remaining twelve are considered potentially eligible. Two of these potentially eligible sites are within the 200-foot wide impact zone for the pipeline. No prehistoric sites known within the gas pipeline corridor are currently enrolled on the National Register of Historic Places.

Sensitive areas for the gas pipeline are believed to be drainage crossings, the Hat Creek Breaks, the Pine Ridge Escarpment, the Hartville Uplift, the crossings of the North Platte and Laramie rivers, Goshen Hole, and sandstone outcrops. Quarry areas, large camps, and stone circle sites are the most common prehistoric site types along the gas pipeline.

2.~~11~~12.B.1 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

General Introduction

a. Detailed syntheses of the ethnohistory (Gilbert and Larson 1981) and history (Schulte 1981) of the region through which the proposed action and alternate railroad route would pass have been prepared for the WyCoalGas Project and are available from the Bureau of Land Management, EIS team, State Office, Cheyenne, Wyoming. These syntheses include cultural and historical sequences from approximately A.D. 1400 to present and discussions of previously known ethnohistoric and historic resources within the project areas and buffer zones.

b. The proposed WyCoalGas Project is located within portions of the Powder River Basin, southeastern Wyoming and northeastern Colorado. This includes parts of Campbell, Converse, Platte and Laramie counties, Wyoming and Weld County, Colorado.

c.(1) The historic site types within the proposed project areas generally relate to one or more of the following topics: civilian and military trails, military instalations, and permanent settlement in the 19th and 20th centuries. Sensitive areas for ethnohistoric and historic resources are those areas which are either known to have or are likely to have sites that may be affected by the project. Sensitive areas are identified for the proposed action and railroad alternative.

c.(2) The eligibility status of any sites discussed in this section is generally that suggested by the original investigators'. In some cases, additional documentation will be required on any of these sites that have not yet been submitted for an eligibility determination.

2.4.8.1 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

General Introduction

a. Detailed syntheses of the ethnohistory (Gilbert and Larson 1981) and history (Gebhardt 1981) of the region through which the proposed action and alternate railroad route would pass have been prepared for the Wyoming Troject and are available from the Bureau of Land Management, BLM team, State Office, Cheyenne, Wyoming. These syntheses include cultural and historical sequences from approximately A.D. 1400 to present and discussions of previously known ethno-historic and historic resources within the project area and buffer zones.

b. The proposed Wyoming Project is located within portions of the Powder River Basin, southeastern Wyoming and northeastern Colorado. This includes parts of Campbell, Converse, Platte and Laramie counties, Wyoming and Weld County, Colorado.

c.(1) The historic site types within the proposed project area generally relate to one or more of the following topics: civilian and military trails, military installations, and permanent settlement in the 19th and 20th centuries. Sensitive areas for ethnohistoric and historic resources are those areas which are either known to have or are likely to have sites that may be affected by the project. Sensitive areas are identified for the proposed action and railroad alternative.

c.(2) The eligibility status of any sites discussed in this section is generally that suggested by the original investigator. In some cases, additional documentation will be required on any of these sites that have not yet been submitted for an eligibility determination.

2.~~11~~12.B.2 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

Rochelle Mine and Buffer Zone

Two historic sites have been recorded within the proposed mine area and two have been recorded in the 1-mile buffer zone. All four sites are 20th century sheepherders' camps and are not considered eligible for the National Register of Historic Places.

Based on present data, the mine area is not considered a highly sensitive area for ethnohistoric or historic era sites. It should be noted, however, that it is considered sensitive for prehistoric resources (see 2.11.A.2) and there is a possibility that some aboriginal sites will contain Euro-American trade goods. It is expected that the historic era sites encountered will be primarily 20th century sheepherders' camps and unpatented homestead claims.

2.~~11~~12.B.3 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

Railroad

No previously recorded ethnohistoric or historic sites are known of within the 1-mile wide corridor investigated for the Class I Ethnohistoric (Gilbert and Larson 1981) or Historic (Schulte) 1981) inventories. A sensitive area for historic resources along the railroad corridor is from Bill south to the proposed plant site. This is because this area contains many ranches, standing individual structures, and foundations, some of which may be either historically or architecturally significant.

2.~~11~~12.B.4 - Affected Environment

Cultural Resources

Ethnohistory and History

Alternate Railroad Route

No previously recorded ethnohistoric or historic sites are known of for the proposed alternate railroad route. The entire portion of the route which parallels Wyoming Highway 59 is considered sensitive because of known but unrecorded standing structures along the highway.

2.~~11~~12.B.5 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

Plant Site and Buffer Zone

No known ethnohistoric or historic sites exist within the proposed plant site or buffer zone. Sensitive areas for ethnohistoric and historic resources are any sites or trail segments relating to the Bozeman Trail, Fort Fetterman, or the early decades of Euro-American settlement of the region.

2.~~11~~12.B.6 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

WATER PROJECTS - reservoir, well fields, pipelines

Four previously recorded historic resources are known to exist within Water Project areas. These are the Little Box Elder Creek Monument, the Unthank grave site, the Oregon Trail and its associated sites and the Bozeman Trail. All, or portions of, these resources are within the Green Valley area field and all are eligible for the National Register of Historic Places. Additionally, the reservoir may alter the visual integrity of historic Fort Fetterman.

Sensitive areas within the Water Project's portion of this project should be considered those ethnohistoric resources associated with the Oregon and Bozeman Trails (including subsequent stage and Pony Express routes) and those relating to the early days of Euro-American settlement of the region.

2.~~11~~12.B.7 - Affected Environment

Cultural Resources

Ethnohistoric and Historic

Gas Pipeline

Five previously recorded historic cultural resources are known to exist within the 1-mile wide corridor for the gas pipeline. All of these resources are either enrolled, nominated, or potentially eligible for the National Register of Historic Places. Shawnee, Wyoming is considered potentially eligible for nomination and is within the 1-mile wide corridor. Register Cliff is on the edge of the 1-mile wide corridor and is enrolled in the National Register of Historic Places. The Hartville-Sunrise Mine District and Cheyenne-Deadwood Stage Route is within the 1-mile wide corridor and portions are in the 200-foot wide impact area. Segments of this district have been nominated for enrollment in the National Register of Historic Places. A portion of the Oregon Trail crosses both the 1-mile wide corridor and the 200-foot wide impact area and is potentially eligible for the National Register of Historic Places. A portion of the Wyoming Hereford Ranch is within both the 1-mile wide corridor and the 200-foot wide impact zone. This historic property is considered potentially eligible for the National Register of Historic Places.

Sensitive areas for the pipeline corridor are considered those resources which are related to the five above mentioned historic properties, trails, or districts; those associated with the early decades of Euro-American settlement of the region; and the areas in the vicinity of Horse Creek which is mentioned in Ethnohistoric accounts.

2.13 SOCIOECONOMICS

A. Introduction

The first step in the socioeconomic assessment process is to identify and analyze the existing socioeconomic environment, paying particular attention to those aspects that are sensitive to change. The analysis then proceeds to the identification of significant impacts due to the proposed action, and subsequently to the development of mitigation strategies.

The description of the affected socioeconomic environment identifies the proposed action's area of site influence and the existing characteristics of those parameters which it would significantly affect. The features of the socioeconomic environment that have been analyzed include population, economy, government, facilities and services (public infrastructure), housing, land use, local jurisdiction expenditures and revenues, and social/cultural conditions.

B. Definition of the Area of Site Influence

The area of site influence (ASI) is the geographic area in which socioeconomic conditions are likely to be significantly affected by the proposed action. The procedure utilized to define the area of site influence was essentially an elimination process which involved several steps. First, a ten-county geographic area where some project effects might occur was defined, and a brief inventory of the communities and the transportation network in that area was carried out. Second, the potential population changes caused by the project (plant, mine, railroad, water supply system, and gas pipeline) were calculated. Finally, future population levels were allocated throughout the study area to determine where the major population changes would occur. The allocation procedure utilized took into account the following criteria:

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-- Relative size of community and its distance (travel time) to the job site

-- Availability, cost, and quality of housing in the community

-- Other amenity attributes of the community

-- Existing labor market conditions and competing development project location and labor demand

-- Trade area relationships

From this evaluation, the counties and communities in Table 2.12-1 were identified as being in the preliminary ASI.

TABLE 2.12-1

COUNTIES AND COMMUNITIES IN PRELIMINARY AREA OF SITE INFLUENCE

County	Communities
Converse	Douglas (M,PL), Glenrock (P)
Campbell	Gillette planning area (M), Wright (M,P)
Natrona	Casper (P), Mills (P), Evansville (P)
Weston	Newcastle (M), Upton (M)
Platte	Wheatland (P) (PL)
Laramie	Cheyenne (PL)

Source: Mountain West Research, Inc., 1981.

Note: (P) = site influence of plant, water supply, and railroad; (M) = site influence of mine; and (PL) = site influence of pipeline.

The demands created by the projected future population in the various counties and communities were then compared to housing and public infrastructure capacities to estimate the significance of the potential impacts in the counties and communities identified above. Through this process, it was determined that the major plant population impacts would occur in Converse County with some minor effects in Natrona County, the mine impacts would occur in Campbell County, and the pipeline effects would occur in Converse, Platte, and Laramie counties.

- Relative size of community and its distance (travel time) to the job site
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C. Regional Overview

1.) BACKGROUND

The purpose of the regional overview discussion is to provide a regional context to the area of site influence and to discuss those activities or services which are regional in nature rather than mainly county- or community-specific. In the latter case, transportation has been identified as the service which is most usefully discussed in a regional context. A transportation system serves the region, and while individual components may belong to a county, the system is most usefully viewed as a whole rather than piece by piece. Some health support and regional services are state sponsored or made available on a regional basis. However, because access to or availability of these services is at the community or county level, these services are discussed in the county/community descriptions.

2.) ECONOMIC/DEMOGRAPHIC OVERVIEW

As noted above, the primary area of site influence for the plant and the mine included Converse County and portions of Natrona and Campbell counties. (The pipeline affects Platte and Laramie counties, but given the differences in the types of impacts which would occur, these counties are described separately and in less detail at the end of this section.) In 1980, this region encompassed a population of about 110,000, or 23.4 percent, of the Wyoming total. As Table 2.12-2 indicates, the regional population increased 57.2 percent during the 1970-80 period. Converse County's 137 percent increase was the largest relative change of the three counties.

The region's recent demographic and economic growth has been a direct result of the rapid development of its coal, oil, gas, and uranium resources. Energy-related growth is expected to continue, although its pace would be affected by the recent decline in uranium activities and by factors affecting coal development.

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TABLE 2.12-2

AREA OF SITE INFLUENCE POPULATION, 1970-1980

Year	County			Region
	Campbell	Converse	Natrona	Total
1970	12,957	5,938	51,264	70,159
1971	12,359	7,387	53,036	72,782
1972	13,080	7,552	53,601	74,233
1973	13,097	7,264	54,820	75,181
1974	14,161	7,896	57,893	79,950
1975	17,140	9,116	62,535	88,791
1976	20,041	10,185	65,592	95,818
1977	21,843	10,810	68,558	101,211
1978	22,640	11,976	71,327	105,943
1979	23,450	13,384	71,592	108,426
1980	24,367	14,069	71,856	110,292
1970-80 (Change (%)	+88.1%	+137%	+40.2%	+57.2%

Sources: Wyoming, Department of Administration and Fiscal Control, Wyoming population and employment forecast report, Cheyenne, Wyoming, 1980; U.S. Department of Commerce, Bureau of the Census, 1980 final population and housing unit counts, Washington, D.C.: U.S. Government Printing Office, January 1981.

TABLE 5.13-5

DEBT TO SITE INFLUENCE FOUNDATION, 1950-1960

Region	Total	Nations	Countries	Cumulative	Year
			Cumulative		
	125,525	42,424	4,134	41,484	1950
	102,634	40,280	4,134	42,420	1951
	102,362	31,363	11,830	43,890	1952
	127,317	23,288	10,830	51,845	1953
	32,078	22,285	15,182	50,041	1954
	96,167	45,252	9,119	41,140	1955
	12,828	21,883	1,828	14,127	1956
	12,183	24,850	1,384	13,061	1957
	14,333	23,801	1,283	13,080	1958
	13,383	22,030	1,283	13,328	1959
	10,128	21,308	2,838	15,321	1960

Sources: Alumni Association of Administration and Finance Centers.
National Institutes of Health, Bureau of Health Manpower, Division of Medical Education and Allied Health Professions, Alumni Association, 1961.
U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1961 Edition and Bureau of Health Manpower, U.S. Department Finance Office, Central Data Center, Washington, D.C., 1961.

3.) TRANSPORTATION

a.) Road Network

The road network is comprised of approximately 800 miles of state and federal highways, jointly maintained by the state of Wyoming and the U.S. government. This primary system is supplemented by a network of county and municipal roads that is maintained by the respective local governmental units.

Of the U.S. highways in the region, Interstate 90 (Campbell County), and Interstate 25 (Converse and Natrona counties) are limited access, four-lane roads. The exception is a section of Interstate 25 in northern Natrona County that is currently two-lane, but would not meet interstate standards until 1981 (Mountain West Research, Inc. 1981a).

All of the state highway links in the area of site influence have either been recently upgraded or are presently undergoing major improvements. See Table 2.12-3.

TABLE 2.12-3

STATE HIGHWAY LINKS IN AREA OF SITE INFLUENCE

State Highway No.	Link(s)	Status
59	Douglas - Gillette	Improvement would be complete by 1982.
387	Edgerton-Reno Junction	Improvement complete
450	Hwy 59, south of Reno Junction-Newcastle	Improvement complete
116	Hwy 450-Upton	Improvement complete

Source: Mountain West Research, Inc., 1981.

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450	Hwy 59, south of Bone Junction-Newcastle	Improvement complete
112	Hwy 450-Upton	Improvement complete

Source: Hunziker West Research, Inc., 1981.

No additional major road improvements are currently planned, with the exception of a collector for mine traffic that is being evaluated by the U.S. Forest Service along the eastern "burn line" of coal deposits in southern Campbell and northern Converse counties.

A remaining problem on the state highway system is the congestion in the city of Douglas on Highway 59 due to north-south traffic. A bypass around Douglas to the west is proposed by state, county, and local authorities, and an application has been made to the Wyoming Farm Loan Board for funds to support the necessary engineering and design activities.

Traffic flows on the state and federal system have shown dramatic increases since 1970. Nevertheless, the current flows are well below the design capacity of the affected highways (see MWRI, Socioeconomic Technical Report, 1981b).

b.) Rail Network

The region is served by lines of the Burlington Northern and Chicago and Northwestern railroads (see Map No. 1, attached). The Orin-Gillette line was recently completed to serve coal transport needs in the southern Powder River Basin. Unit train coal traffic is presently averaging 16 to 18 trains per day (Mountain West Research, Inc. 1981a), with a design capacity of 34 trains per day.

c.) Air Transportation

Commercial air carriers provide access to the region at airports in Casper and Gillette. Both airports also support several fixed base operators. The Natrona County airport near Casper was recently expanded to accommodate the rapid growth in traffic that occurred during the seventies and is expected to continue. It is currently the busiest airport in the state, while the Gillette-Campbell County airport is the second busiest. This latter facility is inadequate for current traffic levels. A plan for expansion to accommodate Boeing-737 class planes has

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b.) Rail Network

The region is served by lines of the Burlington Northern and Chicago and Northwestern railroads (see map No. 1, attached). The Orin-Gillette line was recently constructed to serve coal transport needs in the eastern Powder River Basin. Unit train coal traffic is presently averaging 12 to 14 trains per day (Mountain West Research, Inc. 1981a), with a design capacity of 24 trains per day.

c.) Air Transportation

Commercial air carriers provide access to the region at airports in Casper and Gillette. Both airports also support several fixed base operators. The Natrona County airport near Casper was recently expanded to accommodate the rapid growth in traffic that occurred during the seventies and is expected to continue. It is currently the busiest airport in the state, while the Gillette-Campbell County airport is the second busiest. This latter facility is inadequate for current traffic levels. A plan for expansion to accommodate Boeing-737 class planes has

been submitted to the Federal Aviation Authority (FAA). The project would require federal, state, and local funds totaling nearly $10 million for its implementation (Wyoming Research Corporation 1980).

A third airport, located in Douglas and operated by Converse County, serves light plane traffic. Local authorities have applied to the FAA for funds to build a new facility northwest of Douglas that would be able to accommodate commercial carriers as well as fixed base operators.

D. Discussion of Socioeconomic Components by County

1.) CONVERSE COUNTY

a.) Population

(1) Existing population structure and trends

Since 1940, the population of Converse County has shown alternating decades of decline and growth. As indicated in Table 2.12-4, the decade of the seventies was a period of extremely rapid growth due mainly to energy development. By 1980, 14,069 persons lived in the county, a 137 percent increase over 1970. This growth was distributed among the three incorporated communities -- Douglas, Glenrock, and Lost Springs -- and the rural unincorporated areas. In 1980, Douglas was the largest community in the county, with 43 percent of the population, while Glenrock had 19 percent. Unincorporated areas around Douglas and elsewhere in the county showed significant growth over the decade. However, if current land use policies are maintained by local officials, residential development in unincorported areas would be curbed during the eighties.

(2) Age/sex structure and household size

High levels of in-migration since 1970 have changed the age composition of Converse County's population. Figure 2.12-1 compares the age/sex composition of Converse County in 1980 (estimated) with that in 1970. The bulge in 1980 in the 25-to-44 age group reflects the addition of workers associated with oil, gas, and uranium development, many of

TABLE 2.12-4

COMMUNITY POPULATION, CONVERSE COUNTY, 1970-1980

Community	Population 1970	Population 1980	Change 1970-1980	Proportion of Total Change Accounted for by Each Community
Douglas Division	3,995	9,364	5,369	.660
Douglas Town	2,677	6,030	3,353	.412
Lost Springs Town	7	9	2	.0002
Balance of Division	1,311	3,325	2,014	.248
Glenrock Division	1,943	4,705	2,762	.340
Glenrock Town	1,515	2,736	1,221	.150
Balance of Division	428	1,969	1,541	.190
Converse County	5,938	14,069	8,131	1.000

Source: U.S. Department of Commerce, Bureau of the Census, 1980 final population and housing unit counts, Washington, D.C.: U.S. Government Printing Office, January 1981.

TABLE 2.12-4

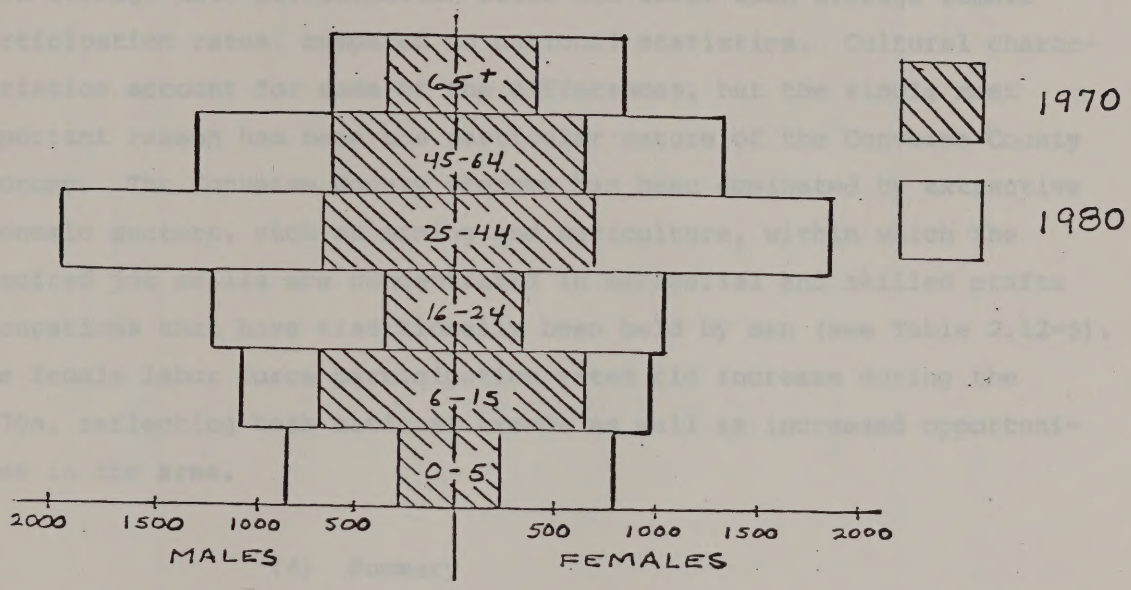
COMMUNITY POPULATION, CONVERSE COUNTY, 1970-1980

Community	Population 1970	Population 1980	Change 1970-1980	Proportion of Total Change Accounted for by Each Community
Douglas Division	3,885	9,349	5,369	.840
Douglas Town	3,677	6,970	3,293	.412
Lost Springs Town	7	9	2	.0002
Balance of Division	1,214	2,325	2,014	.428
Glenrock Division	3,843	4,768	2,925	.348
Glenrock Town	3,515	3,734	1,221	.330
Balance of Division	328	1,345	1,543	.190
Converse County	5,418	14,068	8,121	1.000

Source: U.S. Department of Commerce, Bureau of the Census, 1980 Final Population and Housing Unit Counts, Washington, D.C.: U.S. Government Printing Office, January 1981.

FIGURE 2.12-1

POPULATION STRUCTURE, CONVERSE COUNTY, 1970, 1980



Source: Mountain West Research, Inc. 1981.

Note: 1980 age/sex composition is estimated.

them single. This, coupled with the nationwide trend toward smaller families, resulted in a decline in average household size from 3.01 persons in 1970 to 2.62 in 1980 (U.S. Bureau of the Census 1973a, 1981).

(3) Labor force participation rates

In 1970, 79.4 percent of men and 33.3 percent of women in Converse County participated in labor market activities (either working or unemployed and seeking work). Converse County has historically had higher than average male participation rates and lower than average female participation rates, compared to national statistics. Cultural characteristics account for some of the differences, but the single most important reason has been the particular nature of the Converse County economy. The Converse County economy has been dominated by extractive economic sectors, such as mining and agriculture, within which the required job skills are concentrated in managerial and skilled crafts occupations that have traditionally been held by men (see Table 2.12-5). The female labor force participation rates did increase during the 1970s, reflecting both national trends as well as increased opportunities in the area.

(4) Summary

More than twice as large, with smaller households, greater occupational diversity, and increasing labor force participation rates by women, the Converse County population in 1980 was much changed over 1970. Continued growth in energy-related employment would reinforce these changes in the eighties.

b.) Economy

(1) Background

The economy of Converse County is dominated by mining-related activity (see Table 2.12-5). A significant portion of the mining sector's rise in importance occurred between 1970 and 1980 when its share of total employment increased from 6.9 percent to 29.0 percent. Although oil and gas development has been instrumental in that change, the most

than single. This, coupled with the nationwide trend toward smaller families, resulted in a decline in average household size from 3.01 persons in 1970 to 2.67 in 1980 (U.S. Bureau of the Census 1971a, 1981).

(3) Labor force participation rates

In 1970, 75.4 percent of men and 33.3 percent of women in Converse County participated in labor market activities (either working or unemployed and seeking work). Converse County has historically had higher than average male participation rates and lower than average female participation rates, compared to national statistics. Cultural characteristics account for some of the differences, but the single most important reason has been the particular nature of the Converse County economy. The Converse County economy has been dominated by extractive economic sectors, such as mining and agriculture, within which the required job skills are concentrated in nonpartial and skilled craft occupations that have traditionally been held by men (see Table 3.12-3). The female labor force participation rates did increase during the 1970s, reflecting both national trends as well as increased opportunities in the area.

(4) Mobility

More than twice as large, with smaller households, greater occupational diversity, and increasing labor force participation rates by women, the Converse County population in 1980 was much changed from 1970. Continued growth in mineral-related employment would reinforce these changes in the mixture.

b.) Economy

(1) Background

The economy of Converse County is dominated by mining-related activity (see Table 3.12-2). A significant portion of the mining sector's role in importance occurred between 1970 and 1980 when its share of total employment increased from 5.9 percent to 29.0 percent. Although oil and gas development has been instrumental in that change, the more

TABLE 2.12-5

EMPLOYMENT BY PLACE OF RESIDENCE BY TYPE AND INDUSTRIAL SECTOR, CONVERSE COUNTY, 1970, 1975, 1980

Industrial Sector	Employment by Industrial Sector			Percentage of Total Employment			Average Annual Growth		
	1970	1975	1980	1970	1975	1980	1970-75	1975-80	1970-80
Total Employment	2,341	3,981	7,809	100.0	100.0	100.0	11.2	14.4	12.8
Farm proprietors	311	280	244	13.3	7.0	3.1	-2.1	-2.7	-2.4
Farm Labor	150	217	192	6.4	5.5	2.5	7.7	-2.4	2.5
Mining	162	686	2,266	6.9	17.2	29.0	33.5	27.0	30.2
Construction	174	307	645	7.4	7.7	8.3	12.0	16.0	14.0
Manufacturing	15	44	71	0.6	1.1	0.9	24.0	10.0	16.8
TCPU[a]	203	388	389	8.7	9.7	5.0	13.8	0.1	6.7
Wholesale Trade	28	61	128	1.2	1.5	1.6	16.9	16.0	16.4
Retail Trade	304	478	905	13.0	12.0	11.6	9.5	13.6	11.5
FIRE[b]	50	103	171	2.1	2.6	2.2	15.6	10.7	13.1
Services	229	304	1,071	9.8	7.6	13.7	5.8	28.6	16.7
Government	360	710	905	15.4	17.8	11.6	14.5	5.0	9.7
Other	355	403	822	15.2	10.1	10.5	2.6	15.3	8.8

Source: Mountain West Research, Inc., 1981.

[a]TCPU - Transportation, communication, public utilities.
[b]FIRE - Finance, insurance, real estate.

ANNEX 3.13-2

EMPLOYMENT BY MAJOR SECTOR OF ENTERPRISE BY SIZE AND INDUSTRIAL SECTOR, COMMONWEALTH COUNTRY, 1970, 1975, 1980

Industrial Sector	Employment by industrial sector			Percentage to total employment			Growth rate (annual)		
	1970	1975	1980	1970	1975	1980	70-75	75-80	70-80
Farm proprietors	111	388	314	1.1	0.7	1.1	-1.1	-3.2	-3.4
Farm labor	120	112	141	1.1	0.2	0.4	-1.4	-2.6	2.2
Mining	101	986	1,388	0.9	1.3	0.0	28.2	11.0	20.3
Construction	716	101	143	1.4	1.1	1.8	0.4	0.4	0.4
Manufacturing	75	44	15	0.6	1.7	0.0	12.0	10.0	10.8
$ECMO_a$	383	375	496	1.8	1.4	2.0	1.2	1.0	1.4
Admiralty Trade	81	19	521	1.2	1.2	1.8	8.2	0.4	4.2
Small trade	404	618	808	13.0	12.0	11.4	5.4	7.0	5.2
$ATMC_b$	50	103	137	1.2	1.6	1.3	12.8	10.1	11.1
Services	528	364	1,013	8.8	1.2	12.5	5.8	34.6	10.3
Commerce	303	310	362	12.4	11.4	11.7	14.4	2.0	8.3
Other	325	409	255	14.3	14.1	10.2	2.8	13.3	8.8
Total employment	2,341	2,867	4,084	100.0	100.0	100.0	11.1	14.4	13.8

a ECMO - Australian Government Commonwealth Employment Service.
b ATMC - Australian Tuberculosis Mass Screening Inc., 1981.
Source: Monash Area Research Inc., 1981.

important component of mining growth has been the uranium industry. However, toward the end of 1980, the uranium mining industry in Converse County began declining. Dramatic changes in national markets have resulted in major employment decreases and mining and milling operations curtailments. It is expected that these reductions would most likely continue for the near future.

(2) Employment and income

Between 1970 and 1980, employment in Converse County more than doubled. Of the estimated 7,809 jobs in 1980, about 56.8 percent, or approximately 4,400 jobs, were devoted to basic economic activity (activity originating as a result of demand outside of the study area). Nonbasic employment, defined as activity responding solely to local demand, comprised the remainder. Trade services and government sectors accounted for more than 66 percent of the nonbasic employment total.

Unemployment rates in Converse County rose from 2.1 percent in 1979, to 3.1 percent in 1980 (Wyoming Employment Security Commission 1981). Increases in unemployment in 1980 have accelerated in early 1981 due to depressed housing construction and substantial layoffs in the uranium industry. More significant cutbacks are scheduled in 1981 for uranium mining and milling facilities in the county, driving the unemployment rate higher (Mountain West Research, Inc. 1981c).

During the 1970-80 period, per capita personal income increased at an average annual rate of 11.3 percent to an estimated $11,343 (Mountain West Research, Inc. 1981c). Accounting for approximately 44 percent of labor and proprietors' income in 1978, the mining sector has exerted an important influence on average per capita income. Average wages in the mining sector grew from $9,130 in 1970 to approximately $24,236 by 1978.

(3) Significant trends and influencing factors

In spite of a projected expansion of oil and gas drilling activities in Converse County, the rapid decline of the uranium industry would produce a contraction of the county economy in 1981. This contraction would

important component of mining growth has been the uranium industry. However, toward the end of 1980, the uranium mining industry in Converse County began declining. Dramatic changes in national markets have resulted in major employment decreases and mining and milling operations curtailments. It is expected that these reductions would most likely continue for the near future.

(2) Employment and Income

Between 1970 and 1980, employment in Converse County more than doubled. Of the estimated 7,809 jobs in 1980, about 54.8 percent, or approximately 4,400 jobs, were devoted to basic economic activity activity originating as a result of demand outside of the study area. Nonbasic employment, defined as activity responding solely to local demand, comprised the remainder. Trade services and government services accounted for more than 60 percent of the nonbasic employment total.

Unemployment rates in Converse County rose from 1.1 percent in 1979, to 3.1 percent in 1980 (Wyoming Employment Security Commission 1981). Increases in unemployment in 1980 have accelerated in early 1981 due to decreased housing construction and substantial layoffs in the uranium industry. More significant cutbacks are scheduled in 1981 for uranium mining and milling facilities in the county, driving the unemployment rate higher (Mountain West Research, Inc. 1981a).

During the 1970-80 period, per capita personal income increased at an average annual rate of 11.3 percent to an estimated $11,143 (Mountain West Research, Inc. 1981a). Accounting for approximately 44 percent of labor and proprietors' income in 1978, the mining sector has exerted an important influence on average per capita income. Average wages in the mining sector grew from $24,130 in 1970 to approximately $34,236 by 1978.

(3) Significant trends and Influencing factors

In spite of a projected expansion of oil and gas drilling activities in Converse County, the rapid decline of the uranium industry would produce a contraction of the county economy in 1981. This contraction would

only be reversed by more rapid increases in other basic sector activities, principally those related to coal, oil, and gas.

As Converse County trade centers -- Douglas and Glenrock -- have expanded, they have captured an increasing share of nonbasic or "induced" economic activity. The rate of increase has undoubtedly been somewhat reduced by the presence of Casper, a regional trade center, within easy commuting distance. Nevertheless, the trend toward more extensive trade and service infrastructure within Converse County is expected to be maintained.

c.) Local Government

Converse County operates under a commissioner form of government, where three commissioners constitute the county's policy and administrative board. Both Douglas and Glenrock have a mayor/council form of government with an attendant city administrator. In addition, the county has organized a joint powers board consisting of representatives of the county commissioners and the two city councils who deal with problems common to both cities and/or the rural areas. (Mountain West Research, Inc. 1981b.)

d.) Government Facilities and Services

(1) Converse County

(a) General administrative services and protective services

The county's major administrative offices include the county assessor, the county clerk, the county treasurer, and the staff to the county commissioners. Protective services are provided by the county sheriff, the justice system, the county attorney's office, and the probation and parole office. These services are adequately staffed and have sufficient space for their functions, with the exception of the county attorney's office. From 1979 to 1980, the district court filings increased by 31 percent. With this increase in case load, there has been no increase in staff. Under these conditions, higher salaries in the private sector have made filling positions difficult (Mountain

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West Research, Inc. 1981d). The justice system adjusted to the higher work load by recently changing from a justice of the peace court to the present county court (see MWRI, Socioeconomic Technical Report, 1981b).

(b) School districts

Converse County has two school districts: District No. 1 serves Douglas and eastern Converse County; District No. 2 serves Glenrock and western Converse County. In addition to offering grades K-12, the district provides special education, continuing education, and recreation. The only physical plant deficiencies are in District No. 2 (see Table 2.12-6); however, planned facility additions for 1982 would overcome the problem. Because of these facility constraints, the student/teacher ratio in District No. 2 is quite high: 20.7 to 1, compared to 17.4 to 1 in Douglas and 13.6 to 1 statewide. When the district moves into the new buildings, additional teachers would be hired. Staffing in District No. 1 is sufficient -- both the district and the state regard a student/teacher ratio of 18 to 1 as adequate (see Mountain West Research 1981b).

(c) Libraries; health and human services

The county library system has a main facility in Douglas and a branch in Glenrock. An expansion of the Glenrock branch is now planned (Mountain West Research, Inc. 1981e). Health and human services are delivered by county, regional, and state offices which include: the County Health Department, Division of Public Assistance and Social Services (DPASS), Eastern Wyoming Mental Health Center, County Vocational Rehabilitation Office, Job Service, and the Agricultural Extension Service. With the exception of the county health department, all of the services are funded by state or federal agencies. (Mountain West Research, Inc. 1981f, 1981g, 1981h, 1981i, 1981j).

The 32-bed hospital in Douglas is county owned. Plans have been approved to construct a new 44-bed hospital. Presently, the community has a severe physician shortage and is in the process of recruiting a doctor. (Present ratio is 1 to 3,000; 1 to 1,200 is national standard

West Research, Inc. 1981d). The justice system adjusted to the higher work load by recently charging from a justice of the peace court to the present county court (see 4000). Socioeconomic Technical Report, 1981b).

(b) School districts

Converse County has two school districts: District No. 1 serves Douglas and eastern Converse County; District No. 2 serves Glenrock and western Converse County. In addition to offering grades K-12, the district provides special education, continuing education, and recreation. The only physical plant deficiencies are in District No. 2 (see Table 2.12-6); however, planned facility additions for 1982 would overcome the problem. Because of these facility constraints, the students/teacher ratio in District No. 2 is quite high: 22.7 to 1, compared to 17.4 to 1 in Douglas and 13.6 to 1 statewide. When the district moves into the new buildings, additional teachers would be hired. Staffing in District No. 1 is sufficient -- both the district and the state regard a student/teacher ratio of 18 to 1 as adequate (see Mountain West Research 1981b).

(c) Libraries, health and human services

The county library system has a main facility in Douglas and a branch in Glenrock. An expansion of the Glenrock branch is now planned (Mountain West Research, Inc. 1981b). Health and human services are delivered by county, regional, and state offices which include: the County Health Department, Division of Public Assistance and Social Services (DPASS), Eastern Wyoming Mental Health Center, County Vocational Rehabilitation Office, Job Service, and the Agricultural Extension Service. With the exception of the county health department, all of the services are funded by state or federal agencies. (Mountain West Research, Inc. 1981c, 1981g, 1981h, 1981i, 1981j).

The 32-bed hospital in Douglas is county owned. Plans have been approved to construct a new 41-bed hospital. Currently, the community has a severe physician shortage and is in the process of recruiting a doctor. (Present ratio is 1 to 3,000; 1 to 1,500 is national standard

TABLE 2.12-6

SCHOOL ENROLLMENT, CAPACITY, AND STUDENT/TEACHER RATIO

District No. 1	Grade	1977	1978	1979	1980	Capacity[a] Maximum[b]	Capacity[a] Optimum[b]
Enrollment	K-5	894	959	979	1,036	1,500	1,300
	6-8	412	438	447	473	700	700
	9-12	494	496	526	568	800	750
	Total	1,800	1,893	1,952	2,077	3,000	2,750
Student/ Teacher Ratio		18.1:1	17.3:1	16.8:1	17.4:1		

District No. 2	Grade	1977	1978	1979	1980	1980-81[b]	1981-82[b]	1982-83[b]
Enrollment	K-5	456	528	655	640	600	600	1,100
	6-8	152	152	168	279		450	450
	9-12	266	288	312	330		600	600
	Total	874	968	1,135	1,249	1,100	1,650	2,150
Student/ Teacher Ratio		18.9	19.5	20.1	20.7			

Source: Mountain West Research, Inc., Socioeconomic technical report, Billings, Montana, 1981.

Note: Excludes rural schools.
[a]Maximum capacities were provided by year.
[b]Capacities were provided utilizing a range regardless of the year

[illegible] Area Planning, Inc., Educational Facilities Bulletin, November, 1981

[illegible] capacities were developed utilizing a space requirement of [illegible] per Area.

[illegible] maximum capacities were developed per Area.

Notes: [illegible] total capacity.

District No. 1	Grade	1981	1982	1983	1984	1985-86p	1986-87p	1987-88p
Ratio Students Teachers		[illegible]	[illegible]	[illegible]	[illegible]			
Kindergarten	K-5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6-8	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	9-12	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

District No. 1	Grade	1981	1982	1983	1984	1985	Maximum capacity	Optimum capacity
Ratio Students Teachers		[illegible]	[illegible]	[illegible]	[illegible]			
Kindergarten	K-5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6-8	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	9-12	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SCHOOL ENROLLMENT, CAPACITY AND STUDENTS\TEACHER RATIO

TABLE 5.13-8

and 1 to 1,311 is the state average.) The dental manpower is somewhat short (1 to 2,400 presently; 1 to 2,000 is optimal). The problem is not regarded as severe. Other medical manpower such as nurses and technicians within the hospital are presently adequate to meet Medicare standards for staffing. (Mountain West Research, Inc. 1981k.)

(2) Town of Douglas

(a) General administrative services and protective services

The city's administrative offices include city administration, city clerk, city treasurer, and planning. Protective services include the police, fire department, and municipal court. Although both administrative and protective services have adequate equipment and staff, there is a severe inadequacy in present office space. (Presently, the city is using storage space for office space. There is no office space for sworn officers or evidence storage.) The city intends to alleviate this problem through an addition to city hall; however, no date has been set for construction (Mountain West Research, Inc. 1981l). The city's fire department is a volunteer organization, with adequate volunteers and equipment to meet emergency situations (Mountain West Research, Inc. 1981m).

(b) Public works

Douglas draws 1.8 MGD of water from the Box Elder Spring formation and up to 2.5 MGD of chlorinated water from the North Platte River. The city's water demand averages 1.7 MGD, and therefore both water supply and treatment have excess capacity to meet peak flow and fire flow. The existing sewage lagoon is capable of serving a population of only 1,900. However, the city has received an EPA 201 planning/design grant which, if funds are available, would result in a 19-acre aerated lagoon, with a capacity for a population of 17,400. Solid waste is collected and processed by the city. The equipment and staffing are adequate for present collection demands, and the landfill would serve the city for 100 years. (Mountain West Research, Inc. 1981n, 1981l.)

and 1 to 1,311 in the state average.) The dental manpower is somewhat short (1 to 2,800 presently; 1 to 2,000 is optimal). The problem is not regarded as severe. Other medical manpower such as nurses and technicians within the hospital are presently adequate to meet Medicare standards for staffing. (Mountain West Research, Inc. 1981k.)

(3) Town of Ruidoso

(a) General administrative services and protective services

The city's administrative offices include city administration, city clerk, city treasurer, and planning. Protective services include the police, fire department, and municipal court. Although both administrative and protective services have adequate equipment and staff, there is a severe inadequacy in present office space. (Presently, the city is using storage space for office space. There is no office space for more officers or attendance arrangements. The city intends to alleviate this problem through an addition to city hall; however, no date has been set for construction (Mountain West Research, Inc. 1981l. The city's fire department is a volunteer organization, with adequate volunteers and equipment to meet emergency situations (Mountain West Research, Inc. 1981m).

(b) Public works

Ruidoso draws 1.5 MGD of water from the Box Elder Spring formation and up to 2.5 MGD of chlorinated water from the North Fork River. The city's water demand averages 1.7 MGD, and therefore both water supply and treatment have excess capacity to meet peak flow and fire flow. The existing sewage lagoon is capable of serving a population of only 1,900. However, the city has received an EPA 201 planning/design grant which, if funds are available, would result in a 18-acre aerated lagoon, with a capacity for a population of 17,400. Solid waste is collected and processed by the city. The equipment and staffing are adequate for present collection demands, and the landfill would serve the city for 100 years. (Mountain West Research, Inc. 1981n, 1981l.)

(3) Town of Glenrock

(a) General administrative services and protective services

The city offices, including the administrator, town clerk, treasurer, and planning staff are located in the new city hall, which is adequate for current use. Protective services include the police department (8-1/2 officers, 4-1/2 dispatchers, and 3 vehicles), the municipal court (part-time judge and clerk), and a volunteer fire department. Equipment, staffing, and office space are presently sufficient to meet service demands of Glenrock (Mountain West Research, Inc. 1981o, 1981p, 1981q).

(b) Public works

The city receives 1.2 MGD of water from its well system. With a storage capacity of 1.6 million gallons, the supply is adequate for both peak and fire flow. In 1981, the city's solid waste site was nearing its capacity, and city officials state that it would need to be replaced by 1985. (Mountain West Research, Inc. 1981; Stuart/Nichols Associates 1978.)

(4) Recreation

Within Converse County, 284 acres of municipal and school parks provide urban recreation opportunities (see Table 2.12-7). The county's major role in these services is the appropriation of funds for community level programs and/or facility construction.

In Douglas, there are 20 undeveloped acres and 104 developed acres of park land in 4 city parks and numerous school sites. Facilities on these lands provide opportunities for tennis, softball, golf, picnicking, swimming, golfing, camping, roller skating, and others (see MWRI, Socioeconomic Technical Report, 1981b). The community's indoor facility (the Community Recreation Center) includes a swimming pool, racquetball courts, riflery range, basketball, volleyball, tennis courts, exercise room, and gymnasiums. Douglas also has a privately owned bowling alley. Programming of facilities by the school/community recreation

TABLE 2.12-7

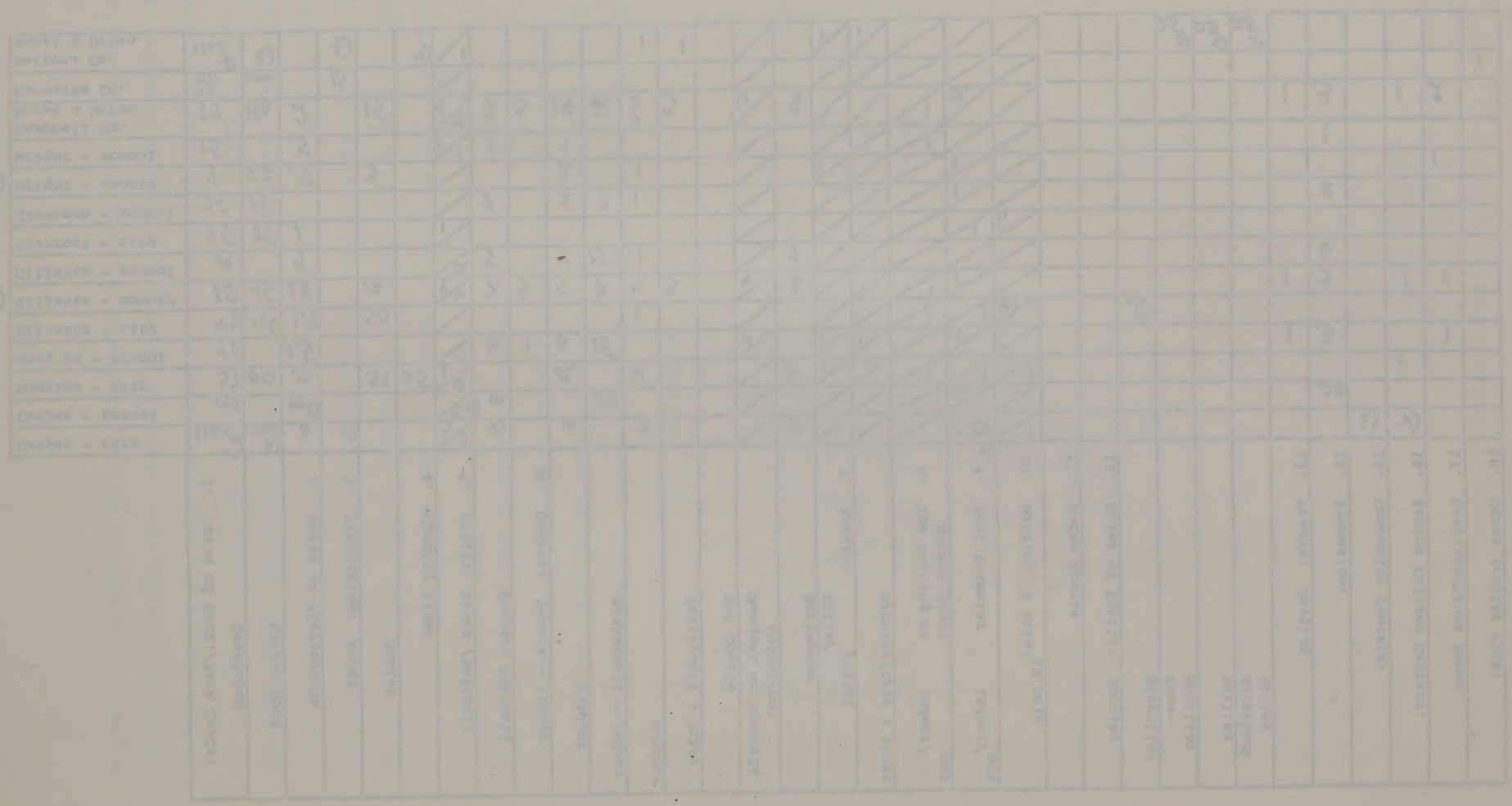
RECREATION INVENTORY -- COMMUNITY FACILITIES

	1. Acres of Recr./Park lands: Developed	Undeveloped	2. Acres of Playgrounds	3. Picnicking: Acres	Tables	4. Camping Sites	5. Fields: Baseb./Softball	Soccer, Football	6. Courts: Tennis - indoor	outdoor	Basketball - indoor	outdoor	Volleyball & Other	M-P Courts	Racquet or handball indoor/out	Horsesnoe	7. Ranges: Rifle/ pistol	Archery/trap & skeet	8. Ice Skating or Hockey Rinks indoor/ out	9. Pool Swimming indoor/ out	10. Golfing 9 hole/ 18 hole	11. Rodeo Arenas	12. Miles of Trails: Jogging	Bicycling	Snow-mobiling	Xskiing	Horseback Riding	13. Tracks: Jogging	14. Gymnasium:	15. Community Centers:	16. Senior Citizen Centers:	17. Exercise/Sauna Rooms	18. Other (roller rink)
Casper - city	1124 j)	1000 k)	8	3)			3 / 5	10		11		3				8				14 n)										i)	1		
Casper - school	195		14 p)				5 / 5 r)	10			28																						
Douglas - city	57	80	.4		37	25	1 / 2			2		4	1			5	1		1	2 / 1	1								28				
Douglas - school	47		1.5				5	6	1	2	15				4		1	1		1											1		
Gillette - city	93	115	1.9		50							1							1	1 / 1	9)			.5				1	3			1	
a) Gillette - county	68	95	1.5		12		9 / 6	2	3	5	2	4	3		6	8			1	1								1	3		1	1	
Gillette - school	19		4				2	3		4	15	1				7													6				
Glenrock - city	35	85	1				1													1	h												
Glenrock - school	25	15						2		2	3	1								1									2				
b) Wright - county	4	22	.5		3					2		1					1			1												1	
Wright - school	15		.5				1 / 1	1		1									1										1				
Campbell Co. Rural & Urban	84	150	2		15		9 / 7	2	3	14	2	5	3		6	8			1	2								1	3		1	2	
Converse Co.	33 30	2000		10																													1
Natrona Co. Rural & Urban	7763 d)	t)		t)		4)	1					1	1				1	1						25 s)	25 s)	25 s)							

Source: Mountain West Research, Inc., 1981.

MWRI, 1981

a b Also included in Campbell County (total)
c Acreage represents fairgrounds only
d Acreage represents 83 acres of fairgrounds plus 7,680 acres of county administered recreation lands
e Owned by National Guard
f Existing structure not in operational condition
g Existing course not in useable condition
h Existing acreage for course undeveloped
i Under construction
j Includes both developed and natural areas, and those currently under construction
k Proposed river development
m 26 areas contain picnic acreages which include shelters and tables
n Include 2 pools and 12 wading pools
p 29 sites, assume .5 acre/site
r Portable backstops
s Same trail used for all 3 activities
t Acreage unknown
u Sites undesignated acreage unknown



staff and the Youth Recreation Board has increased participation in certain activities, thereby creating a current need for additional ball diamonds, racquetball courts, developed park acreage, and bicycle paths (Mountain West Research, Inc. 1981l, 1981r).

Although park land dedication is not mandatory, Glenrock has 60 acres of developed and 100 acres of undeveloped park land. Existing facilities are included in Table 2.12-7. The planned 1981 construction of facilities at the school site would include a football/track stadium; a baseball/softball diamond; tennis, volleyball, and basketball courts; and playground equipment (Mountain West Research, Inc. 1981s). Furthermore, the city recreation master plan identifies development of the existing 80-acre pool/park complex as a top priority, with improvements to include ball diamonds, a rodeo arena, picnic facilities, a motorcross track, and support facilities (The Douglas Budget 1981). Existing inadequacies include the need for one softball diamond. However, with the proposed construction plans, this inadequacy would be met for the existing population. Indoor recreation is currently not available, however, with the exception of the school gymnasium and a privately-owned bowling alley. Although an indoor facility is desired, financial constraints prevent its immediate construction (Mountain West Research, Inc. 1981o).

e.) Housing

The housing stock in Converse County has expanded rapidly during the seventies in response to population growth generated by energy development. Throughout this period, the housing market remained tight. Components which influence the market include housing stock and mix, prices, condition, vacancy rates, supply constraints, and the regulatory framework.

(1) Housing stock and mix

Over the last decade, Converse County housing stock and mix characteristics have changed dramatically (see Table 2.12-8). Overall, the number of dwelling units in the county increased by 133 percent during

staff and the Youth Recreation Board has increased participation in certain activities, thereby creating a current need for additional ball diamonds, racquetball courts, developed park acreage, and bicycle paths (Mountain West Research, Inc. 1981, 1981a).

Although park land dedication in San Anselmo, Ulmstown has 80 acres of developed and 100 acres of undeveloped park land. Existing facilities are indicated in Table 2.12-7. The planned 1981 construction of facilities at the school site would include a football/track stadium, a baseball/softball diamond, tennis, volleyball, and basketball courts and playground equipment (Mountain West Research, Inc. 1981a). Furthermore, the city recreation master plan identifies development of the existing 20-acre pool/park facility as a top priority, with improvements to include ball diamonds, a tot-lot area, picnic facilities, a motocross track, and support facilities (Jim Douglas Budget 1981). Existing inadequacies include the need for one softball diamond. However, with the proposed construction plans, this inadequacy would be met for the existing population. Indoor recreation is currently not available, however, with the acquisition of the school gymnasium and a privately-owned bowling alley. Although an indoor facility is desired, financial constraints prevent its immediate construction (Mountain West Research, Inc. 1981b).

e.) Housing

The housing stock in Converse County has expanded rapidly during the seventies in response to population growth generated by energy development. Throughout this period, the housing market remained tight. Components which influence the market include housing stock and mix, prices, condition, vacancy rates, rental constraints, and the regulatory framework.

(1) Housing stock and mix

Over the last decade, Converse County housing stock and mix characteristics have changed dramatically (see Table 2.12-8). Overall, the number of dwelling units in the county increased by 123 percent during

TABLE 2.12-8

CONVERSE COUNTY HOUSING STOCK AND MIX, 1970-1980

	Units											
	Converse County			Douglas			Glenrock			Unincorporated Areas		
Housing Type	1970	1980	% Change	1970	1980	% Change	1970	1980	% Change	1970	1980	% Change
Single Family	1,741	3,047	+75	795	1,353	+70	396	618	+56	550	1,076	+96
(% of Total)	(77%)	(58%)		(75%)	(59%)		(77%)	(57%)		(87%)	(57%)	
Multifamily	254	639	+152	197	371	+ 88	57	268	+370	-	-	-
(% of Total)	(11%)	(12%)		(18%)	(16%)		(11%)	(25%)				
Mobile Home	252	1,554	+517	74	550	+643	61	201	230	117	803	+586
(% of Total)	(11%)	(30%)		(7%)	(24%)		(12%)	(18%)		(10%)	(43%)	
TOTAL	2,247	5,240	+133	1,066	2,274	+113	514	1,087	+111	667	1,879	+182
%	(100%)	(100%)		(100%)	(100%)		(100%)	(100%)		(100%)	(100%)	
Percent Owner Occupied	70%	n.a.		65%			71%			n.a.		

Sources: U.S. Department of Commerce, Bureau of the Census. 1970. Housing characteristics for states, cities and counties, Wyoming. Washington, D.C.: U.S. Government Printing Office, 1973; Mountain West Research, Inc., survey of Converse County tax records, March 1981. Excludes seasonal dwelling units.

[a]Excluding seasonal units.
[b]Including townhouses.

COMPARE COMMON BOARDING HOUSE AND MIX, 1910-1980

AVERA E-15-8

Boarding type	1910	1980	% change	1910	1980	% change	1910	1980	% change	1910	1980	% change
	Compare county			Compare county			Compare county			Compare county		
	U M I A M											
Single family	1,347	1,083	-20	147	1,121	+10	336	918	+44	328	2,038	+60
(% of total)	(12%)	(10%)		(12%)	(25%)		(12%)	(17%)		(12%)	(18%)	
Multifamily	524	888	+135	121	331	+88	22	302	+130	-	-	-
(% of total)	(11%)	(15%)		(12%)	(7%)		(11%)	(12%)				
Hospital home	325	1,224	+271	14	408	+283	10	301	+230	113	883	+278
(% of total)	(11%)	(13%)		(12%)	(10%)		(11%)	(12%)				
Total	3,341	3,340	+133	1,008	3,512	+113	358	1,871	+113	441	3,839	+143
(% of total)	(100%)	(100%)		(100%)	(100%)		(100%)	(100%)		(100%)	(100%)	
Average owner occupied		10%	U.M.		53			17%			U.M.	

the decade, with the period of most rapid expansion occurring between 1975 and 1978 when approximately 1,130 units were added to the housing stock (Wyoming Department of Economic Planning and Development 1979). During the 1970-80 period, the average number of persons/dwelling unit increased slightly, from 2.64 to 2.68 persons.

Mobile home and single family detached units accounted for 88 percent of the housing mix in 1980, while multifamily dwellings made up the remaining 12 percent (see Table 2.12-8). Since 1970, mobile homes accounted for an increasing share of the housing market. In 1970, mobile homes accounted for 11 percent of the total housing stock in Converse County. By 1980, the mobile home share was 30 percent. Over the same period, single family share of the housing stock fell from 77 percent to 58 percent.

Unit cost inflation and high interest rates have accelerated the trend toward less costly mobile home and multifamily units. From 1978 to 1980, 523 units were added; 11 percent were single family detached, 31 percent were multifamily (including townhouses), and 58 percent were mobile home units (Mountain West Research, Inc. 1981b.)

Converse County's transient lodging accommodations are concentrated around Douglas and total nearly 400 motel rooms plus 200 camping/RV spaces (Mountain West Research, Inc. 1981b).

(2) Housing prices, conditions, and vacancy rates

The 1980 median price of newly constructed, single family detached dwellings in Converse County ranged from $65,000 to $70,000. Homes in Douglas averaged $70,000, while those in Glenrock averaged $68,000. At current lending rates, these homes are no longer affordable for most of the population (Mountain West Research, Inc. 1981b).

Mobile home prices vary widely, depending upon the type of unit. In 1980, a 14 foot by 80 foot average unit cost about $27,000. Townhouses and condominiums cost somewhat less than single family dwellings, while

the decade, with the period of most rapid expansion occurring between 1975 and 1978 when approximately 1,120 units were added to the housing stock (Wyoming Department of Economic Planning and Development 1979). During the 1970-80 period, the average number of persons/dwelling unit increased slightly, from 2.64 to 2.68 persons.

Mobile homes and single family detached units accounted for 86 percent of the housing mix in 1980, while multifamily dwellings made up the remaining 12 percent (see Table 2.12-8). Since 1970, mobile homes accounted for an increasing share of the housing market. In 1970, mobile homes accounted for 13 percent of the total housing stock in Converse County. By 1980, the mobile home share was 30 percent. Over the same period, single family share of the housing stock fell from 77 percent to 58 percent.

Cost over inflation and high interest rates have accelerated the trend toward less costly mobile homes and multifamily units. From 1978 to 1980, 321 units were added: 11 percent were single family detached, 71 percent were multifamily (including townhouses), and 18 percent were mobile home units (Economic Research Associates, Inc. 1981a).

Converse County's transient housing accommodations are concentrated around Douglas and total nearly 100 motel rooms plus 300 dwelling/RV spaces (Mountain West Research, Inc. 1981b).

(2) Housing prices, conditions, and vacancy rates

The 1980 median price of newly constructed, single family detached dwellings in Converse County ranged from $65,000 to $70,000. Homes in Douglas averaged $70,000, while those in Glenrock averaged $60,000. At current lending rates, these homes are no longer affordable for most of the population (Mountain West Research, Inc. 1981b).

Mobile home prices vary widely, depending upon the type of unit. In 1980, a 14 foot by 60 foot average unit cost about $27,000. Townhouses and condominiums cost somewhat less than single family dwellings, while

apartment unit rents averaged $375 in Douglas and $300 in Glenrock (Wyoming Department of Economic Planning and Development 1980a, 1981b). In 1980, monthly rental rates for single family homes -- both old and new -- averaged around $550 (Mountain West Research, Inc. 1981b).

The quality of Converse County housing stock in 1978 was relatively good: 5.6 percent of housing was classified "substandard" (Wyoming Department of Economic Planning and Development 1979). In addition, by 1980, over half of the county's total housing was less than ten years old.

Indicative of tight housing market conditions in the county have been low vacancy rates. In 1980, they were estimated to be 4 to 5 percent (Mountain West Research, Inc. 1981t), with the vacancy rate for assisted housing units effectively at 0 and that for mobile home spaces at about 4 percent (Mountain West Research, Inc. 1981b). During 1981, this pressure on existing housing is being offset by units becoming available due to the precipitous decline in uranium industry employment.

(3) Housing supply conditions

Housing development capacities in Converse County are generally good. During the 1970-80 period, up to approximately 200 single family, 250 mobile home, and 100 multifamily units were added in peak years by Converse County builders and developers. Moreover, land available for development is plentiful. Property that is either subdivided or in the subdivision planning stages totals over 6,700 additional dwelling unit sites, much of it concentrated in Douglas and Glenrock (Mountain West Research, Inc. 1981b).

Constraints which may limit Converse County developers/builders' capacities to respond to any large, future upswing in housing demand include high construction and financing costs (which make it difficult for developers to undertake large residential construction projects without some certainty of occupancy), limited subcontractors, construction labor, and building materials supplies.

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Indicative of tight housing market conditions in the county have been low vacancy rates. In 1980, they were estimated to be 4 to 5 percent (Mountain West Research, Inc. 1981a), with the vacancy rate for assisted housing units effectively at 0 and that for mobile home spaces at about 4 percent (Mountain West Research, Inc. 1981b). During 1981, this pressure on existing housing is being offset by units becoming available due to the precipitous decline in uranium industry employment.

(3) Housing supply conditions

Housing development conditions in Converse County are generally good. During the 1970-80 period, up to approximately 200 single family, 150 mobile home, and 100 multifamily units were added in peak years by Converse County builders and developers. Moreover, land available for development is plentiful. Property that is either subdivided or in the subdivision planning stages totals some 4,100 additional dwelling units alone, much of it concentrated in Douglas and Glenrock (Mountain West Research, Inc. 1981b).

Constraints which may limit Converse County developers/builders' capacities to respond to any large, future upswing in housing demand include high construction and financing costs (which make it difficult for developers to undertake large residential construction projects without some certainty of occupancy), limited subcontractors, construction labor, and building materials supplies.

(4) Housing development regulations

The Converse County Land Use Plan (Converse County Planning Commission 1978) and current zoning policies favored by the county planning board and local officials emphasize the concentration of future residential development within the city limits of Glenrock and Douglas and within a one-mile radius of designated rural centers. These policies, combined with local permitting procedures and high housing costs, would induce much higher density development than has been recently experienced and reinforce the change in mix away from single family detached units.

f.) Land Use

(1) Rural County

The 1978 county land use plan discourages the conversion of lands from agricultural to other uses and encourages orderly residential development within designated incorporated centers. Rural residential development outside of these centers must be in an approved subdivision. These policies assure that future growth would be controlled so as to reverse the recent trend of dispersed, spontaneous residential growth in the rural areas.

(2) Town of Douglas

Commercial areas in Douglas lie along major highways, with most residential development north and west of Douglas. Approximately two-thirds of the land within the city limits is vacant, the major portion being zoned residential (Mountain West Research, Inc. 1980a). Table 2.12-9 provides a breakdown by use. Several residential subdivisions exist outside municipal boundaries, but within the city's planning area (Douglas Planning Commission 1981).

Existing land use plans and zoning regulations encourage development within the city limits (Douglas Planning Commission and Converse County

(d) Housing development regulations

The Converse County Land Use Plan (Converse County Planning Commission 1978) and current zoning policies favored by the county planning board and local officials emphasize the concentration of future residential development within the city limits of Glenrock and Douglas and within a one-mile radius of designated rural centers. These policies, combined with local permissive procedures and high housing costs, would induce much higher density development than has been recently experienced and reinforce the change in mix away from single family dwelling units.

2.1 Land Use

(1) Rural County

The 1978 county land use plan discourages the conversion of lands from agricultural to other uses and encourages orderly residential development within designated incorporated centers. Rural residential development outside of these centers might be in an approved subdivision. These policies assure that future growth will be controlled so as to reverse the recent trend of dispersed, spontaneous residential growth in the rural areas.

(2) Town of Douglas

Commercial areas in Douglas lie along major highways, with most residential development north and west of Douglas. Approximately two-thirds of the land within the city limits is vacant, the major portion being zoned residential (Mountain West Research, Inc. 1980a). Table 2.12-9 provides a breakdown by use. Several residential subdivisions exist outside municipal boundaries, but within the city's planning area (Douglas Planning Commission 1981).

Existing land use plans and zoning regulations encourage development within the city limits (Douglas Planning Commission and Converse County

TABLE 2.12-9

CITY OF DOUGLAS -- LAND USE, 1980

Use	Existing Acres	Vacant Acres	Total Acres
Residential	387.85	1,337.95[a]	1,725.80
Commercial	66.48	135.8	202.28
Industrial	31.79	43.19	74.98
Public/Quasi-Public	252.14	74.8	326.94
TOTAL	738.26	1,591.74	2,330.00

Source: Mountain West Research, Inc., 1981.

Note: Excludes transportation land uses.

[a]Excludes 148.30-acre airport site within the city.

Planning Commission 1976). Even so, constraints due to infrastructure deficiencies and flood plain locations preclude development of some vacant acres. Pending policies and decisions which may affect future land use include the proposed airport relocation, a Highway 59 bypass, and the annexation of the Brownfield Tract (south of the city limits). (Mountain West Research, Inc. 1980a.)

(3) Town of Glenrock

Glenrock land use patterns include an older core area with mixed residential and commercial development, while newer residential developments are to the east, south, and west (see Table 2.12-10). Approximately two-thirds of the city's acres are vacant, with nearly all of this (546 acres) designated for residential use (Mountain West Research, Inc. 1980b). As in Douglas, numerous residential subdivisions surround the community.

Policies in the 1978 land use plan include no further annexation, with concentration on development of existing vacant acres. Present water and sewer infrastructure constrain some development and expansion in areas of higher elevation, however. (Glenrock Planning Commission and Converse County Planning Commission 1978.) The present zoning ordinances are under revision by the city.

g.) Fiscal

This section presents a brief overview of the historical and current fiscal condition of the major governmental entities in Converse County. Revenue and expenditure trends are discussed for county, municipal, and school district budgets. It should be noted that the 1981 Wyoming legislature passed a sales tax impact assistance measure aimed at getting funds into impacted communities "up front" when impacts are actually occurring. The effect of this tax has been included in the revenue estimates.

TABLE 2.12-10

TOWN OF GLENROCK -- EXISTING LAND USE, 1981

Use	Existing Acres	Vacant Acres	Total Acres
Residential	216.06	546.20	762.26
Commercial	21.13	20.74	41.87
Industrial	38.72	159.93	198.65
Public/Quasi-Public	64.69	12.74	77.43
Agricultural	4.84		4.84
TOTAL	345.46	739.61	1,085.05

Source: Mountain West Research, Inc., 1981.

TABLE 2.12-10

TOWN OF GLENROCK -- EXISTING LAND USE, 1981

Use	Existing Acres	Vacant Acres	Total Acres
Residential	216.06	546.30	762.36
Commercial	21.13	20.74	41.87
Industrial	34.72	154.93	189.65
Public/Semi-Public	54.49	17.74	72.23
Agricultural	4.24		4.24
TOTAL	345.44	739.71	1,085.75

Source: Boulder Mountain Land Research, Inc., 1981.

(1) Converse County

Between 1975 and 1980, total revenues increased at an annual average rate of approximately 30 percent. This trend is expected to continue with property taxes accounting for 59.2 percent of total 1981 budgeted revenue and sales taxes comprising 10.7 percent. (See Table 2-12-11.) Total expenditures increased at a rate of 33.9 percent during the same 1975-80 period, while general funds expenditures increased by 41.4 percent annually.

(2) Douglas

Although the growth of Douglas' revenues has slowed in recent years, the large cash balances carried forward in FY 1980-81 left a sound fiscal base. The additional oil and gas severance tax and sales tax impact assistance measure, enacted by the 1981 legislature, should enhance the town's ability to finance future growth.

Between 1979 and 1980, the years for which actual revenue data are available, total revenues increased by 36 percent. The sales tax was the largest source of revenue, accounting for an estimated 24.9 percent of general fund revenue in 1981. Between 1978 and 1980, general fund expenditures increased at an annual average rate of 6.9 percent.

(3) Glenrock

Between 1975 and 1980, total revenues increased at an average annual rate of 26.8 percent (see Table 2.12-11). As in Douglas, sales taxes comprised the largest source of revenue in 1981. Total expenditures increased at an annual average rate of 24.3 percent. General fund expenditures grew at a slightly faster rate of 32.8 percent.

The recent national economic recession and its effect on the construction sector has led to lower revenues than expected for the town of Glenrock. As a result, several new service programs were not able to be undertaken as anticipated. However, the additional oil and gas severance tax which was recently passed by the 1981 legislature should significantly improve the town's revenue outlook.

(1) Dorchester County

Between 1975 and 1980, total revenues increased at an annual average rate of approximately 10 percent. This trend is expected to continue with property taxes accounting for 52.7 percent of total 1981 budgeted revenue and sales taxes contributing 10.1 percent. (See Table 2-12-11.) Total expenditures increased at a rate of 13.9 percent during the same 1975-80 period, while general funds expenditures increased by 11.4 percent annually.

(2) Cambridge

Although the growth of Cambridge's revenues has slowed in recent years, the large cash balances carried forward in FY 1980-81 left a sound fiscal base. The additional oil and gas severance tax and sales tax impact assistance measure, enacted by the 1981 legislature, should enhance the town's ability to finance future growth.

Between 1979 and 1982, the years for which actual revenue data are available, total revenues increased by 16 percent. The sales tax was the largest source of revenue, accounting for an estimated 24.4 percent of general fund revenue in 1981. Between 1979 and 1982, general fund expenditures increased at an annual average rate of 8.1 percent.

(3) Elkton

Between 1975 and 1980, total revenues increased at an average annual rate of 24.8 percent (see Table 2.12-11). As in Cambridge, sales taxes comprised the largest source of revenue in 1981. Total expenditures increased at an annual average rate of 24.1 percent. General fund expenditures grew at a slightly lower rate of 22.2 percent.

The recent national economic recession and its effect on the construction sector has led to lower revenues than expected for the town of Elkton. As a result, several new capital programs were not able to be undertaken as anticipated. However, the additional oil and gas severance tax which was recently passed by the 1981 legislature should significantly improve the town's revenue outlook.

TABLE 2.12-11

REVENUE AND EXPENDITURE HISTORY

	Actual 1975	Actual 1976	Actual 1977	Actual 1978	Actual 1979	Actual 1980	Annual Average Percent Change 1975-1980	Budget 1981
Converse County								
Revenues	1,754.2	2,904.3	3,535.3	3,506.1	5,378.9	6,502.5	30.0	5,616.7
Expenditures	1,318.0	1,810.2	2,664.2	2,775.1	4,322.4	5,683.5	33.9	5,508.0
Town of Glenrock								
Revenues			786.3	987.3	1,328.8	1,602.8	26.8	1,505.4
Expenditures			770.0	911.4	1,353.3	1,479.4	24.3	1,505.4
School District No. 1								
Revenues			5,825.9	7,366.7	9,526.1	10,997.4	23.6	11,333.5
Expenditures			3,751.4	3,886.3	5,369.4	6,660.1	21.1	11,333.6
School District No. 2								
Revenues			2,193.9	2,381.8	2,876.8	3,620.7	18.2	4,633.5
Expenditures			1,826.0	2,046.3	2,113.9	2,603.6	12.6	4,633.5
Town of Douglas								
Revenues				1,963.6[a]	4,598.3	6,253.3	36.0	5,908.0
Expenditures				1,735.7[a]	4,670.5[a]	6,376.9[a]	51.0	5,981.3

Source: Compiled by Mountain West Research, Inc., 1981, from district budgets.

Note: Totals may not sum due to rounding; figures represent thousands of dollars.

[a]Budget.

APPENDIX AND EXPENDITURE RATIONS

TABLE 3.11-II

	1981 Actual	1982 Actual	1983 Actual	1984 Actual	1985 Actual	1986 Actual	1987-1988 Percent Change Budget Variance	1981 B-1988
Courses Courses								
Revenues	1,124.3	2,484.3	2,223.1	1,805.1	4,318.4	2,703.7	0.0%	5,674.1
Expenditures	1,310.4	1,870.3	2,808.5	3,112.7	4,252.5	5,643.3	27.0	7,268.0
School District No. 1								
Revenues			180.3	284.3	4,638.8	8,208.1	0.0%	1,802.4
Expenditures			117.0	818.4	1,123.3	7,418.4	34.2	1,202.4
School District No. 2								
Revenues			2,232.3	1,304.1	4,638.1	10,281.4	27.0	27,223.2
Expenditures			1,127.4	2,888.2	7,268.1	1,049.1	37.1	11,323.8
School District No. 3								
Revenues			5,161.3	1,183.1	3,318.8	4,328.8	20.5	2,123.2
Expenditures			8,832.1	3,840.1	1,123.4	2,402.8	52.8	2,123.2
Total of Revenues								
Revenues				98,138.1	2,328.4	3,323.2	32.0	4,808.6
Expenditures				1,124.1	4,218.2	2,312.8	25.0	4,109.3

(4) Converse County School District No. 1

Between 1975 and 1980, general fund total revenues increased at an annual average rate of 23.6 percent, while expenditures increased by 21.1 percent.

The recent fiscal history of Converse County School District No. 1 has been favorable. The FY 1980-81 budget reflects a sizable cash carry forward and includes expenditures of $3.3 million for non-program charges. This balance is placed in the construction fund and is available for school building construction. At the beginning of FY 1980-81, the district was bonded to 32.7 percent of total borrowing capacity. District No. 1 does not receive state foundation program funds.

(5) Converse County School District No. 2

Recent bond issues have left Converse County School District No. 2 bonded to over 98 percent of total borrowing capacity. The current policy of equalizing the assessed valuation per pupil between the county's two districts has aided the financial situation of District No. 2. Even so, a sizable portion of capital expenditures is still financed from the general fund. The district presently levies the maximum 25 mills for operations. Like District No. 1, District No. 2 does not receive state foundation program payments. The district local property taxes account for 49.8 percent of the budgeted 1981 revenues.

h.) Social Characteristics

(1) Community social structure and processes

(a) Douglas

Douglas is a community presently undergoing change in its social and decision-making structure. For many years, the major employment sector in the county was agriculture, with Douglas serving primarily as a trade center for nearby ranchers. Energy-related growth has brought a rapid increase in population and employment. By 1978, the mining sector replaced agriculture as the major employer in the county economy. The

implication to Douglas has been a large influx of new residents to the community. In contrast to the existing population of Douglas, many of these newcomers are residentially mobile, given the nature of the energy industry, and they have different age, occupational, and family characteristics than the longer-term residents. For example, the number of working age adults and young children has increased both in absolute numbers and as a percentage of total community population. The net effect has been that many of the traditional social interactions and governmental procedures in the community are changing. For example, it is no longer possible to know or at least recognize everyone in the community; people with different economic and demographic characteristics are beginning to become part of the community, and their contributions and demands differ from those of the long-time residents. In addition, demands on government services are increasing, causing a change both in number of personnel and procedures.

Douglas is presently adjusting to and accommodating the changes brought by the energy growth of the 1970s. Although the high mobility of many newcomers does not facilitate familiarity among community residents and hinders participation of newcomers in community and governmental activities, it does appear that newcomers are becoming integrated into the community. As a result, both the formal organizations and institutions in the community (local government; churches; and fraternal, civic, and social organizations) and the informal networks for community decision-making and socializing are expanding to include both long-term residents and newcomers. Through this process, the community is gaining experience and confidence dealing with a more diversified population.

(b) Glenrock

Glenrock's history and location have influenced its social organization significantly. The proximity of oil fields, uranium and coal mines, and the Dave Johnston power plant has resulted for many years in a large number of permanent community residents who are not and have not been associated with the agricultural sector. The high proportion of

legislation in Douglas has been a large influx of new residents to the community. In contrast to the existing population of Douglas, many of these newcomers are residentially mobile, given the nature of the energy industry, and they have different age, occupational, and family characteristics than the long-term residents. For example, the number of working age adults and young children has increased both in absolute numbers and as a percentage of local community population. The net effect has been that many of the traditional social interactions and governmental procedures in the community are dynamic. For example, it is no longer possible to know or at least recognize everyone in the community; people with different economic and demographic characteristics are beginning to become part of the community, and their contributions and demands differ from those of the long-time residents. In addition, demands on government services are increasing, creating a change both in number of personnel and procedures.

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(2) Glenrock

Glenrock's history and location have influenced its social organization significantly. The proximity of oil fields, uranium and coal mines, and the Dave Johnston power plant has resulted for many years in a large number of permanent community residents who are not and have not been associated with the agricultural sector. The high proportion of

Glenrock residents in the mining, manufacturing, and TCPU (transportation, communication, and public utilities) sectors illustrate this point. The existing social structure in Glenrock reflects the occupational diversity in the community as well as the fact that the population of the community has been composed of both long- and short-term residents for some time.

Despite its proximity and economic ties to Casper, it is clear that many Glenrock residents have a strong sense of community and oppose seeing the town lose its identity and evolve either into a bedroom community for Casper or for large numbers of temporary energy workers who would have no ties or interest in the community. This concern has developed in response to the fact that downtown retail and service sector growth has been inhibited by the nearness of Casper and the full range of goods and services it offers, and that Douglas, not Glenrock is the governmental center of Converse County.

(2) Lifestyles, attitudes, and values

Long-time residents in both Douglas and Glenrock have maintained many of their traditional values and lifestyle characteristics. However, the influx of new persons has decreased the commonality of lifestyle in the communities while increasing the number of social groups in each. This has affected Douglas more than Glenrock. Consequently, although both communities in Converse County have maintained a conservative economic, political, and social stance, there has been an increased acceptance of land use controls and zoning (Mountain West Research, Inc. 1981b), increased use of governmental services, and increased opportunities open to females. As is typical in rural communities throughout the United States, the residents of Converse County favor economic/industrial growth, though expressing concern over uncontrolled growth and the effects of energy development on the stability of the area and its lifestyles (Albrecht 1978; Murdock and Leistritz 1979; Mountain West Research, Inc. 1975, 1981b; Thompson 1980; Uhlman et al. 1976; Massey 1977).

At this time, there appears to be a sense within both communities that energy development is inevitable and that the communities and county must prepare for and influence that development (Mountain West Research, Inc. 1981b). There is widespread interest by residents in the communities and county to find out what would happen and in developing procedures to address growth issues. To date, some mechanisms such as planning, land use, and zoning regulations and the joint powers board have been established to deal with immediate growth issues.

(3) Indicators of well-being

The issue of social well-being and the psychological effects of energy development on individuals has been raised by various researchers. Some indicators have been developed to identify when "well-being" problems are occurring. Measures which have been identified as useful indicators of well-being include rates of individual behavior (e.g., suicide, crime, divorce, infant mortality, child and spouse abuse, alcohol and drug abuse, and school drop-out), case loads of helping institutions and agencies (e.g., public assistance and welfare, mental health, and unemployment), economic status (e.g., per capita income distribution, inflation, and cost of living), and availability/quality of facilities and services (e.g., housing characteristics, school classroom size, and retail goods and services). Data on these indicators for the study area are included in the Socioeconomic Technical Report (Mountain West Research, Inc. 1981b).

Although these data must be interpreted cautiously since a variety of factors affect the measurement and significance of these indicators, the data for Converse County do not indicate a high level of social problems and do indicate favorable economic status for the population as a whole. Interviews with service agency representatives and community residents confirm the view that Converse County is not experiencing extraordinary problems in terms of the social well-being of its residents.

At this time, there appears to be a sense within both communities that energy development is inevitable and that the communities and county must prepare for and minimize that development (Geometric Mass Research, Inc. 1981). There is widespread interest by residents in the communities and county to find out what would happen and in developing procedures to address social issues. To date, some mechanisms such as planning, land use, and zoning regulations and the joint powers board have been established to deal with immediate growth issues.

(3) Indicators of Well-Being

The issues of social well-being and the psychological effects of energy development on individuals have been raised by various researchers. Some indicators have been developed to identify when "well-being" problems are occurring. Resources which have been identified as useful indicators of well-being include rates of individual behavior (e.g., suicide, crime, divorce, income mobility, child and spouse abuse, alcohol and drug abuse, and mental disorder), rates levels of behavior indicators and economic (e.g., public assistance and welfare, mental health, and unemployment), economic status (e.g., per capita income distribution, migration, and cost of living), and availability/quality of facilities and services (e.g., tourism characteristics, school classroom size, and health needs and services). Data on these indicators for the study area are included in the Socio-economic Technical Report (Mountain West Research, Inc. 1981).

Although these data must be interpreted cautiously since a variety of factors affect the measurement and significance of these indicators, the data for Converse County do not indicate a high level of social problems and do indicate favorable overall status for the population as a whole. Interviews with service agency representatives and community residents confirm the view that Converse County is not experiencing extraordinary problems in terms of the social well-being of its residents.

2.) NATRONA COUNTY

a.) Population and Economic Conditions

In 1980, Natrona County had a population of 71,589, an increase of over 20,000 people since 1970. While Casper remained the population center of the county (56,036 in 1980), its share of the county declined from 91 percent in 1970 to 78 percent in 1980. (See Table 2.12-12.)

Recently, population growth in the county and its communities has slowed due to the depressed conditions of the uranium and housing construction industries. Also, household size declined from 3.12 to 2.52 between 1970 and 1980, which implies greater housing unit demand and lower school enrollments per capita. It is anticipated, however, that since Casper is a regional trade center, energy-related activities in the surrounding counties would provide some growth stimulus for the Casper area.

Per capita personal income grew at an annual rate of 10.3 percent between 1970 and 1978 when it was $11,415 (U.S. Department of Commerce, Bureau of Economic Analysis 1980). The 1980 per capita income estimate is $12,469 (Mountain West Research, Inc. 1981c). Unemployment in the county has been low since 1970, being at 3.1 percent in 1980 (Wyoming Employment Security Commission 1981).

b.) Government Facilities and Services

(1) Natrona County

(a) County administrative and protective services

Of the various services offered by the county, only the county court is experiencing capacity problems (see MWRI, Socioeconomic Technical Report, 1981b).

(b) School district

The facilities of Natrona County's school district are crowded with grades K-9 presently exceeding capacity levels (see Table 2.12-13). The

3.1 MATRONA COUNTY

a.) Population and Economic Conditions

In 1980, Matrona County had a population of 71,384, an increase of over 25,000 people since 1970. While Casper remained the population center of the county (52,024 in 1980), the state of the county declined from 31 percent in 1970 to 74 percent in 1980. (See Table 3.12-12.)

Recently, population growth in the county and its communities has slowed due to the depressed conditions of the uranium and booming coal-extractive industries. Also, tourmaline was declined from 3.12 to 3.52 between 1970 and 1980, which implies greater housing vacancy rates and lower school enrollments per capita. It is anticipated, however, that since Casper is a regional trade center, energy-related activities in the surrounding counties would provide some growth stimulus for the Casper area.

Per capita personal income grew at an annual rate of 12.7 percent between 1970 and 1979 when it was $11,310 (U.S. Department of Commerce, Bureau of Economic Analysis 1981). The 1980 per capita income estimate is $12,460 (Mountain West Research, Inc. 1982). Unemployment in the county has been low since 1970, being at 3.1 percent in 1980 (Wyoming Employment Security Commission 1981).

b.) Government Facilities and Services

(1) Matrona County

(a) County administrative and protective services

Of the various services offered by the county, only the county court is experiencing capacity problems (see MRM, Socioeconomic Technical Report, 1982).

(b) School districts

The facilities of Matrona County's school districts are crowded with grades K-3 presently exceeding capacity levels (see Table 3.12-13). The

TABLE 2.12-12

COMMUNITY POPULATION, NATRONA COUNTY, 1970-80

Community	1970 Population	1970 Share of Total (%)	1980 Population	1980 Share of Total (%)	1970-80 Change Population	1970-80 Change Share of Total (%)
Casper Divsion	46,711	91	57,698	80	10,987	53
Casper City	39,361	77	51,016	71	11,655	57
Mills Town	1,724	3	2,139	3	415	2
Balance of Division	5,626	11	4,543	6	-1,083	-6
Casper North Division	1,998	4	4,243	6	2,245	11
Casper South Division	2,185	4	4,916	7	2,731	13
Evansville	832	1.6	2,652	4	1,820	9
Balance of Division	1,353	2.6	2,264	3	911	4
Hells Half Acre Division	370	1	4,999	7	4,629	23
Natrona County	51,264	100%	71,856	100%	20,592	100%

Sources: U.S. Department of Commerce, Bureau of the Census, 1980 final population and housing unit counts, Washington, D.C.: U.S. Government Printing Office, January 1981.
includes Edgerton and Midwest.

TABLE 2.12-13

ENROLLMENT AND CAPACITY BY ELEMENTARY, JUNIOR HIGH AND HIGH SCHOOL, SCHOOL DISTRICT NO. 1 -- NATRONA COUNTY

Grade	Enrollment 1977	1978	1979	1980	Capacity
K-6	6,894	7,183	6,981	7,411	6,800
7-9	3,124	3,013	2,894	2,868	2,500
10-12	3,345	3,103	3,176	2,933	3,300
TOTAL	13,363	13,299	13,051	13,212	12,600

Source: Mountain West Research, Inc., Socioeconomic technical report, Billings, Montana, 1981.

county is presently using 51 temporary classrooms. A recent successful bond issue would allow 25 units to be replaced by 1981. (Mountain West Research, Inc. 1981u.)

(c) Health and human services

Memorial Hospital of Natrona County offers a full range of specialty care, with 104 physicians and a 282-bed capacity. There are 2 nursing homes in Casper, 54 general practitioners, 38 dentists, 6 chiropractors, 5 nurse practitioners, 8 optometrists, 70 pharmacists, and 1 psychiatrist. All of these services are considered adequate for the population service area. The county public health department, however, is inadequately staffed. (Mountain West Research, Inc. 1981v.)

(2) City of Casper

(a) General administrative services, protective services, public works

The city's administrative offices are located in a new building which has excess capacity. Protective services, including the police department and municipal court, are located in the new hall of justice, while fire fighters are located at five stations. Staff, equipment, and facilities for administrative and protective services are considered adequate. (Mountain West Research, Inc. 1981b.)

The city draws and treats 12 to 18 MGD from the North Platte River and 22 MGD from wells. The average daily demand is 9.5 to 9.9 MGD. With expansions now under construction, the water supply and treatment would continue to have excess capacity. Sewage is treated in a two-stage sludge plant with a capacity of 6.5 MGD. At present, this plant runs very near capacity with peak flows of 6.04 MGD. The sewage collection system has some deficiencies, however, causing leakages to occur during peak flows. The manpower, facilities, and equipment for public works departments are adequate with the exception of the sewage collection system.

(3) Recreation

The community of Casper has 50 park sites encompassing 623 acres of developed land, 406 acres of natural areas, and 1 ski area. In addition, there are 1,100 acres pending development. The YMCA, Community Recreation, Inc., a private racquet club, and Natrona County schools provide most of the indoor recreation facilities for the community.

Currently, there is a need for 14 tennis courts, 7 baseball fields, 7 softball fields, and 1 swimming pool. Additional indoor recreation facilities are also needed, but construction of a public indoor facility in 1981-82 would alleviate much of this need. (Mountain West Research, Inc. 1981w.) Private enterprise also provides recreation facilities including 2 golf courses, a racquetball club, tennis facilities, and 5 bowling alleys.

c.) Housing

Natrona County has had a tight housing market over the last 10 years. This is reflected by a low vacancy rate (1 percent in 1978, according to the Wyoming Department of Economic Planning and Development) and high housing costs, with the average cost of an 1,100-square-foot home in Casper in 1980 at $95,000 (Wyoming Department of Economic Planning and Development 1980c). Over the last decade, the number of mobile homes in the county has increased as has the mobile home share of total dwelling units in the county (see Table 2.12-14).

Although housing conditions have been tight, there is enough platted land in the county to add 4,949 additional housing units (Natrona County Planning Office 1980). Also, local builders have a large capacity, as evidenced by local residential developers bringing more than 7,000 units into existence between 1970 and 1980.

(3) Recreation

The community of Casper has 50 park sites encompassing 533 acres of developed land, 468 acres of natural areas, and 1 ski area. In addition, there are 1,150 acres pending development. The YMCA, Community Recreation, Inc., a private racquet club, and Natrona County schools provide most of the indoor recreation facilities for the community.

Currently, there is a need for 14 tennis courts, 7 basketball courts, 7 softball fields, and 1 swimming pool. Additional indoor recreation facilities are also needed, but construction of a public indoor facility in 1981-82 would alleviate much of this need. (Mountain West Research, Inc. 1981a.) Private enterprises also provide recreation facilities including 2 golf courses, a racquetball club, tennis facilities, and 3 bowling alleys.

c.) Housing

Natrona County has had a tight housing market over the last 10 years. This is reflected in a low vacancy rate (1 percent in 1979, according to the Wyoming Department of Economic Planning and Development) and high housing costs, with the average cost of an 1,400-square-foot home in Casper in 1980 at $68,000 (Wyoming Department of Economic Planning and Development 1980). Over the last decade, the median of mobile homes in the county has increased as has the median home sales of total dwelling units in the county (see Table 2.22-14).

Although housing conditions have been tight, there is enough platted land in the county to add 2,344 additional housing units (Natrona County Planning Office 1980). Also, local builders have a large capacity, as evidenced by local residential developments totaling more than 7,000 units into existence between 1970 and 1980.

TABLE 2.12-14

UNIT DISTRIBUTION BY TYPE, NATRONA COUNTY, 1978

Unit Type	Casper	Greater Casper Area	Casper Suburban Area	Balance of Natrona County
Single Family	12,566	16,077	3,511	812
Multifamily	3,868	3,999	131	10
Mobile Home	655	3,415	2,760	78
TOTAL	17,089	23,491	6,402	900
Percent of Total Housing Stock	70%	96%	26%	4%

Source: Natrona County Planning and Zoning Commission, Land use plan, Natrona County, Casper, Wyoming, 1978.

d.) Fiscal

(1) Natrona County

Total revenue in Natrona County increased at an annual average rate of 18.6 percent between 1975 and 1980. Similarly, expenditures increased at an annual average rate of 23.8 percent between 1977 and 1978. (Mountain West Research, Inc. 1981b.) Property taxes accounted for 25.9 percent of total 1981 budgeted revenues, and sales taxes comprised 26.6 percent.

(2) Casper

Since 1976, revenues have increased at an annual average rate of 37 percent, while general fund revenues increased at a rate of 24.5 percent. For FY 1981, the major source of revenue is anticipated to be the 3 percent sales tax, generating 65 percent of the total general fund revenue. Anticipated expenditures for the year 1981 total $44,707,000, while the 1981 budgeted revenues are $50,503.000. (Mountain West Research, Inc. 1981b.)

Recent inflationary trends have led to the adoption of a FY 1980-81 budget which reflects no expansion of services. However, the oil and gas severance tax and the sales and use tax impact assistance measure, both passed by the 1981 legislature, should significantly improve the city's revenue outlook.

(3) Natrona County School District No. 1

Between 1977 and 1980, revenues increased at an annual average rate of 17.1 percent to reach the 1981 level of $36,167,000. The district received a substantial portion of its revenue from the state foundation program, accounting for 52.1 percent of total budgeted revenues in 1981. General fund total expenditures increased at an annual average rate of 17.1 percent during the 1977-80 period.

6.1 Trends

(1) Maricopa County

Total revenue in Maricopa County increased at an annual average rate of 16.6 percent between 1975 and 1981. Similarly, expenditures increased at an annual average rate of 17.8 percent between 1975 and 1979. (Mountain Bell Research, Inc. 1981.) Property taxes accounted for 73.9 percent of total 1981 budgeted revenues, and sales taxes comprised 26.6 percent.

(2) Casper

Since 1976, revenues have increased at an annual average rate of 17 percent, while general fund revenues increased at a rate of 14.5 percent. For FY 1981, the major source of revenue is anticipated to be the 3 percent sales tax, accounting for 43 percent of the total general fund revenue. Anticipated expenditures for the year 1981 total $14,707,000, while the 1981 budgeted revenues are $20,363,800. (Mountain West Research, Inc. 1981.)

Recent inflationary trends have led to the adoption of a FY 1982-83 budget which reflects no expansion of services. However, the oil and gas severance tax and the sales and use tax impact stabilization measure, both passed in the 1981 legislature, should significantly improve the city's revenue outlook.

(3) Moscow County School District No. 1

Between 1973 and 1980, revenues increased at an annual average rate of 17.1 percent to reach the 1981 level of $14,107,700. The district received a substantial portion of its revenue from the state foundation program, accounting for 51.1 percent of total budgeted revenue in 1981. General fund total expenditures increased at an annual average rate of 17.1 percent during the 1973-80 period.

The FY 1980-81 budget reflects a cash carry-forward of $2.2 million, or 30.4 percent, of total revenues. Increases in district revenues have allowed for expansion of some programs and for increased costs due to inflation. At the beginning of FY 1980-81, the district was bonded to 67.4 percent of its total borrowing capacity.

e.) Social Characteristics

Natrona County's complex social organization incorporates residents of diverse backgrounds and characteristics, while Casper, an urban area, has evolved a complex social structure no longer dependent on primary social ties. Due to its urban nature, lifestyles are diverse and are influenced largely by the prevailing western ethic and the age, occupation, and family characteristics of its residents (Mountain West Research, Inc. 1981x; Blau and Duncan 1967).

3.) CAMPBELL COUNTY

a.) Population

Campbell County's population has grown rapidly since 1960; it has increased by 88 percent, from 12,957 in 1970 to 24,367 in 1980. Gillette, the major city and the only incorporated community in the county, accounted for 50 percent of the 1980 county population, while Wright, a new unincorporated town in the northern part of the county, had 5 percent of the county population (see Table 2.12-15).

b.) Economy

Total Campbell County employment more than doubled between 1970 and 1980. There were 14,621 jobs in the county in 1980 (Mountain West Research, Inc. 1981c). Coal mining was the driving force in the economy, with the trade, services, and government sectors also expanding.

Over the last 10 years, unemployment rates in Campbell County have been low, reaching 2.6 percent in 1979 and 3.8 percent in 1980 (Wyoming Employment Security Commission 1981). Layoffs in the uranium industry are affecting Campbell County proportionately less than either Converse

The FY 1980-81 budget reflects a deficit carry-forward of $2.2 million, or 30.4 percent, of total revenues. Increases in district revenues have allowed for expansion of some programs and for increased costs due to inflation. As the beginning of FY 1980-81, the district was bonded to 87.4 percent of its total bonding capacity.

4.1 Social Characteristics

Nations County's complex social organization incorporates residents of diverse backgrounds and characteristics, while Cheyenne, an urban area, has evolved a complex social structure to longer dependent on primary social ties. Due to its urban setting, Cheyenne's ills are diverse and are influenced largely by the prevailing service sector and the age, occupation, and family characteristics of its residents (Mountain West Research, Inc. 1979; Ellis and Dobson 1981).

5.1 CHAUTAUQUA COUNTY

5.1 Population

Chautauqua County's population has grown rapidly since 1970; it has increased by 48 percent, from 12,000 in 1970 to 24,387 in 1980. Cheyenne, the county seat and the only incorporated community in the county, accounted for 36 percent of the 1980 county population, with eight, a few unincorporated towns in the northern part of the county, had 3 percent of the county population (see Table 5.11-1).

5.2 Economy

Total Chautauqua County employment more than doubled between 1970 and 1980. There were 4,811 jobs in the county in 1980 (Mountain West Research, Inc. 1981). Coal mining was the driving force in the economy, with the trade, services, and government sectors also expanding.

Over the last 10 years, unemployment rates in Chautauqua County have been low, reaching 3.6 percent in 1979 and 5.3 percent in 1980 (Wyoming Employment Security Commission 1981). Benefits in the tourism industry are attracting Chautauqua County proportionately less than either Converse

TABLE 2.12-15

COMMUNITY POPULATION, CAMPBELL COUNTY, 1970, 1980

Community/Area	Population (% of county total) 1970	1980	Percent Change 1970-80	Proportion of Total Change
Gillette North Division	9,886 (76%)	18,853 (77%)	+91	.786
Gillette City	7,194 56%	12,134 50%	+69	.433
Prospector-Rawhide Village	-	1,098 5%	-	.096
Balance of Division	2,692 (21%)	5,621 (45%)	+109	.257
Gillette South Division	3,071 (24%)	5,514 (23%)	80	.214
Wright	-	1,115 5%	-	.098
Balance of Division	3,071 (24%)	4,399 (18%)	43	.166
Campbell County Total	12,957 (100%)	24,367 (100%)	+88	1.000

Source: U.S. Department of Commerce, Bureau of the Census, 1980 final population and housing counts, Washington, D.C.: U.S. Government Printing Office, 1981.

TABLE 2.12-15

COMMUNITY POPULATION, CAMPBELL COUNTY, 1970, 1980

Community/Area	Population (% of County Total) 1970	1980	Percent Change 1970-80	Proportion of Total Change
Gillette North Division	9,986 (20%)	10,351 (27%)	+4%	.06
Gillette City	7,194 32%	12,134 32%	+69	.412
Rozencrans-Jacobs Village	-	1,090 3%	-	.006
Remainder of Gillette	2,402 (14%)	3,521 (18%)	+47%	.177
Gillette South Division	3,071 (24%)	5,372 (22%)	0%	.234
Wright	-	1,127 3%	-	.006
Balance of Division	1,011 (12%)	4,159 (18%)	+3	.164
Campbell County Total	13,997 (100%)	34,760 (100%)	+85	1.000

Source: U.S. Department of Commerce, Bureau of the Census, 1980 Final Population and Housing Counts, Washington, D.C.; U.S. Government Printing Office, 1981.

or Natrona County. Thus, total employment is not projected to decline in Campbell County in 1981.

Consistent with other counties in the region, Campbell County's growth has been reflected in rapidly rising per capita income, which reached $12,944 by 1980 (Mountain West Research, Inc. 1981c). The mining sector has played an important role in this growth, and coal development would continue to drive the county's economic growth in the 1980s. Gillette would continue to emerge as a trade center with expansion in the service and retail and wholesale trade sectors enabling a greater share of the secondary economic effects from development to be captured locally.

c.) Local Government

Campbell County is administered by three elected commissioners and three employees. Gillette, the only incorporated city in the county, elects a mayor and six council members for four-year terms each. In addition, there is an attendant city administrator.

d.) Government Facilities and Services

(1) Campbell County

(a) General administrative services and protective services

Administrative offices include the assessor's office, agricultural extension service, treasurer's office, and the planning office. Protective services include the sheriff's office, justice of the peace court, county attorney, probation and parole office, and fire departments. With the exception of the sheriff's office, all service categories are considered adequately staffed. The county and city volunteer fire department is organized as one unit and adequately meets the fire protection needs of the county (Mountain West Research, Inc. 1981y).

of Barrons County. Thus, total employment is not anticipated to decline in Campbell County in 1983.

Consistent with other counties in the region, Campbell County's growth has been reflected in rapidly rising per capita income, which reached $12,914 by 1980 (Mountain West Research, Inc., 1981). The mineral sector has played an important role in this growth, and coal development would continue to drive the county's economic growth in the 1980s. Climate would continue to emerge as a trade center with expansion in the service and retail and wholesale trade sectors enabling a greater share of the secondary economic effects from development to be captured locally.

2.) Local Government

Campbell County is administered by seven elected commissioners and three employees. Gillette, the only incorporated city in the county, elects a mayor and six council members, for four-year terms each. In addition, there is an appointed city administrator.

3.) Government Facilities and Services

(1) Campbell County

(a) General administrative services and protective services

Administrative offices include the county's office, agricultural extension service, treasurer's office, and the planning office. Protective services include the sheriff's office, justice of the peace court, county attorney, probation and parole office, and jail operations. With the exception of the sheriff's office, all service categories are considered adequately staffed. The county and city volunteer fire departments are organized as one unit and adequately serve the fire protection needs of the county (Mountain West Research, Inc. 1981).

(b) School district

The Campbell County school district encompasses the entire county. It provides instruction in grades K-12, continuing education, and special education; it currently has excess capacity at every level. Construction is planned to meet projected enrollment increases, including a swimming pool, an elementary school, additions to the high school in Gillette, and a secondary school in Wright (Mountain West Research, Inc. 1981z). The district has maintained adequate staffing to meet the growth in enrollment.

(c) Health and human services

The county health department has six nurses who provide immunization, screening, and health maintenance services (Mountain West Research, Inc. 1981n).

There is a 120-bed skilled care nursing home located in Gillette. The Memorial Hospital of Campbell County recently moved into a new 52-bed building which has 27 practicing physicians. Current levels of use at the hospital indicate the need to expand this facility. The county also operates three ambulances, two in Gillette and one in Wright. Although demands are growing for vocational rehabilitation, mental health, and public assistance services, these are adequately staffed. (Mountain West Research, Inc. 1981aa.)

(2) City of Gillette

(a) General administrative services and protective services

These services include the city clerk, treasurer, planning office, police, and municipal court. Administrative offices are located throughout the city. The city now owns the old high school which would be remodeled or replaced by a new building to alleviate present space problems (Mountain West Research, Inc. 1981bb). Current staffing levels are considered adequate.

(b) School districts

The Campbell County School District encompasses the entire county. It provides instruction in grades K-12, continuing education, and special education; it currently has excess capacity at every level. Construction is planned to meet projected enrollment increases, including a vocational school, an elementary school, additions to the high school in Gillette, and a secondary school (Montgomery Ward Research, Inc. 1981a). The district has rehabilitation programs starting to meet the growth in enrollment.

(c) Health and human services

The county health department has six nurses who provide immunization, screening, and health maintenance services (Mountain West Research, Inc. 1981b).

There is a 120-bed skilled care nursing home located in Gillette. The Memorial Hospital of Campbell County recently moved into a new 32-bed building which has 27 psychiatric overflows. Nursing hours at the hospital indicate the need to expand this facility. The county also operates three ambulances, one in Gillette and one in Wright. Although demands are growing for vocational rehabilitation, mental health, and public assistance services, these are currently staffed. (Mountain West Research, Inc. 1981a.)

(3) City of Gillette

(a) General administrative services and protective services

These services include the city clerk, treasurer, planning office, police, and municipal court. Administrative offices are located throughout the city. The city has owns the old high school which would be remodeled or replaced by a new building to alleviate present space problems (Mountain West Research, Inc. 1981b). Current staffing levels are considered adequate.

(b) Public works

Gillette presently receives its water from 28 wells, which meets current needs. However, when completed, the Gillette-Madison project would be able to deliver 43 additional MGD from the well location 42 miles east of Gillette. The city uses a sewage plant to treat its waste water. Its 1.6 MGD capacity is designed to be more than adequate through the year 2002. Solid waste is proposed to be disposed of at the Wyodak mine site. (Mountain West Research, Inc. 1981cc.)

(3) Town of Wright

Because the town of Wright is unincorporated, all services are provided by the county. These services (water, sewer, fire, schools, etc.) all have excess capacity. (Mountain West Research, Inc. 1981b.)

(4) Recreation

The Gillette area currently has 180 acres of developed park land and 211 acres of undeveloped land. Adequate facilities need to be developed on these undeveloped lands (Mountain West Research, Inc. 1981dd, 1981ee).

A mandatory park land dedication ordinance assures that adequate acreage is set aside, but development funds are often delayed. Indoor facilities are numerous, but programming of these facilities has increased the participation level beyond their capacity (Mountain West Research, Inc. 1981ee). The private sector assists in meeting the community's recreation needs. At present, there is a miniature golf course, an 18-hole golf course, tennis/racquetball courts, and a 20-lane bowling alley.

The community of Wright is well supplied with both indoor and outdoor public recreation facilities.

e.) Housing

(1) Housing stock and composition

In 1980, total Campbell County housing stock reached an estimated 9,562 units, up from 3,937 units in 1970 (a 143 percent increase). In spite of this, the housing market remains extremely tight (see Table 2.12-16).

According to an April 1979 housing survey of the Gillette/Campbell County area, 42 percent of the dwelling units were single family detached units, 12 percent were multifamily units, and 46 percent were mobile homes (Gillette/Campbell County Planning Commission 1978). In 1980, a similar housing survey was conducted for Gillette which indicated the following housing mix: 47 percent single family detached units, 19 percent multifamily units, and 26 percent mobile homes (Gillette Department of Planning and Development 1980). Contrary to the experience of Converse and Natrona counties, where mobile homes and multifamily dwellings have been most in demand over the past two years, Campbell County housing demand has shifted toward single family dwellings.

(2) Housing prices, conditions, and vacancy rates

In 1980, the average cost of an 1,100-square foot, three-bedroom home in Gillette was about $69,000, while rental rates for similar units were in the $350 to $375 range (Wyoming Department of Economic Planning and Development 1980d).

The housing market in Campbell County is very tight. In Gillette, vacancy rates are 2 to 3 percent overall and 1 percent or less for rental units (Mountain West Research, Inc. 1981bb). In Wright, there are currently about 40 units under construction and 185 lots available for development (Mountain West Research, Inc. 1981ff). ARCO also plans to expand the mobile home area in the summer of 1981.

Nearly 60 percent of housing units in Campbell County are ten years old or less. Housing conditions are good.

a.) Housing

(1) Housing stock and occupancy

In 1980, total Campbell County housing stock reached an estimated 9,441 units, up from 8,977 units in 1970 (a 4.7 percent increase). In spite of this, the housing market remains extremely slack (see Table 2.12-16).

According to an April 1979 housing survey of the Gillette-Campbell County area, 49 percent of the dwelling units were single family detached units, 22 percent were multifamily units, and 29 percent were mobile homes (Gillette/Campbell County Planning Commission 1979). In 1980, a similar housing survey was conducted for Gillette which indicated the following housing mix: 47 percent single family detached units, 19 percent multifamily units, and 34 percent mobile homes (Gillette Department of Planning and Development 1980). Contrary to the experience of Cheyenne and Western counties, where mobile homes and multifamily dwellings have been most in demand over the past few years, Campbell County housing demand has shifted toward single family detached units.

(2) Housing prices, conditions, and vacancy rates

In 1980, the average cost of an 1,100-square foot, three-bedroom home in Gillette was about $69,000, while market rates for similar units were in the $130 to $170 range (Western Companies of Economic Planning and Development 1980).

The housing market in Campbell County is very slack. In Gillette, vacancy rates are 0 to 1 percent overall and 1 percent or less for rental units (Mountain West Research, Inc. 1980). In Wright, there are currently about 40 units under construction and 140 lots available for development (Mountain West Research, Inc. 1980b). AMCO also plans to expand the mobile home area in the summer of 1981.

Nearly 50 percent of housing units in Campbell County are ten years old or less. Housing conditions are good.

TABLE 2.12-16

CAMPBELL COUNTY DWELLING UNITS BY TYPE

Type of Unit	Gillette City 1970[a]	Gillette City 1980[b]	Gillette Planning Area - 1980[b]	Wright 1980[c]	Balance of County - 1980[d]	Campbell County 1970[a]	Campbell County 1980	Total 1970-80 change
Single Family								
Number of units	1,074	2,273	617	111	916	1,782	3,917	+120%
Percent of total	40%	47%	41%	20%	35%	45%	41%	
Multifamily								
Number of units	441	951	74	5	12	491	1,042	+112%
Percent of total	20%	19%	5%	1%	-	13%	11%	
Mobile Home								
Number of units	713	1,274	702	334	1,695	1,664	4,005	+141%
Percent of total	32%	26%	46%	61%	65%	42%	42%	
Other								
Number of units	n.a.	379	118	101	n.a.	n.a.	598	-
Percent of total		8%	8%	18%			6%	
TOTAL	2,228	4,877	1,511	551	2,623	3,937	9,562	+143%
	100%	100%	100%	100%	100%	100%	100%	

Sources: [a]U.S. Department of Commerce, Bureau of the Census, 1970 population and housing survey, Washington, D.C.: U.S. Government Printing Office, 1971.

[b]Gillette Department of Planning and Development, 1980 housing survey, Gillette, Wyoming, April 1980.

[c]Mountain West Research, Inc., Housing units, (phone conversation), Walter Wierzbick, Director, ARCO Housing Services, Inc., Wright, Wyo. January 21, 1981.

[d]Mountain West Research, Inc., 1981.

[e]Includes occupied R.V.s, nursing homes, hotel/motel rooms rented by week or longer.

CURRENT CORDLESS DRILLING NOISE BY TYPE

TABLE 5.15-16

(3) Housing supply

A recent study reported the following information regarding housing supply: single family units, 4 months supply; multifamily units, 13 months supply; mobile home sites, 1 months supply; and subdivided lots, 15 months supply (Friendswood Development Company and Campbell County Chamber of Commerce 1980). Gillette, by virtue of its growth over the last 10 years, has housing developers/builders who are presently capable of producing 700 to 900 units (including mobile home pads) per year.

(4) Constraints and influencing factors

High construction costs and mortgage rates have dampened demand for single family units in Campbell County. These factors would continue to be important influences on the mix of developed housing. Development policies in the county place few restrictions on residential growth as long as subdivision requirements are met.

f.) Land Use

Currently, there are few land use policies in the rural county area; these do not restrict development which meets subdivision regulations. Consequently, spontaneous residential growth continues to occur. Gillette has progressive planning and zoning regulations and little unplatted land remaining within its boundaries. Annexation policy modifications and future plans call for the accommodation of future growth. Developments within the community of Wright are subject to approval by Housing Services, Inc., established by ARCO.

g.) Fiscal

(1) Campbell County

During the period of 1975-80, total revenue grew at an annual average rate of 28.3 percent, while expenditures increased at a rate of 32.8 percent. Property taxes accounted for 48.0 percent of the total 1981 budgeted revenue, and sales taxes accounted for 17.3 percent. The 1981 expenditures are expected to increase significantly over the 1980 level to $16,592,000 (see MWRI, Socioeconomic Technical Report, 1981b).

(3) Housing supply

A recent study reported the following information regarding housing supply: single family units, 4 months supply; walk-in only units, 12 months supply; mobile home sites, 1 month supply; and subdivided lots, 12 months supply (Greenbrier Development Company and Campbell County Chamber of Commerce 1980). Gillette, by virtue of its growth over the last 10 years, has housing developers/builders who are presently capable of producing 700 to 800 units (including mobile home pads) per year.

(4) Constraints and influencing factors

High construction costs and mortgage rates have depressed demand for single family units in Campbell County. These factors would continue to be important influences on the mix of designed housing. Development policies in the county place few restrictions on residential growth as long as subdivision requirements are met.

E.) Land Use

Currently, there are few land use policies in the rural county areas there do not restrict development which meets subdivision regulations. Consequently, spontaneous residential growth continues to occur. Gillette has progressive planning and zoning regulations and little unplatted land remaining within its boundaries. Annexation policy modifications and future plans call for the accommodation of future growth. Developments within the community of Wright are subject to approval by Mountain Services, Inc., established by ARCO.

G.) Fiscal

(1) Campbell County

During the period of 1975-79, total revenue grew at an annual average rate of 28.3 percent, while expenditures increased at a rate of 32.6 percent. Property taxes accounted for 48.0 percent of the total 1981 budgeted revenue, and sales taxes accounted for 17.3 percent. The 1981 expenditures are expected to increase significantly over the 1980 level to $16,572,000 (see Korz, Socioeconomic Technical Report, 1981b).

(2) City of Gillette

Gillette's revenues and expenditures for 1977-80 are displayed in Table 2.12-17. Sales taxes in 1981 were the largest source of city revenue, accounting for 10.7 percent of total budgeted revenue.

The FY 1980-81 budget for Gillette reflects an attempt to provide the same level of service as in the past. The revenue estimates, however, were based on the discontinuation of the 1 percent optional sales tax which was ultimately approved by the voters in November 1980. Moreover, impact assistance measures recently passed by the Wyoming legislature should substantially improve the city's revenue outlook.

(3) Campbell County School District No. 1

Energy development projects in Campbell County have created a favorable financial situation for Campbell County School District No. 1. Although the district levies the full 25 mills for operations, it was only at 12.8 percent of its total borrowing capacity at the beginning of FY 1980-81. The district's large property tax base allows financing of some capital expenditures with the operations budget.

In 1981, the property tax was the largest source of revenue, accounting for 46.9 percent of total budgeted revenue. Total expenditures between 1977 and 1980 increased at an average annual rate of 33.7 percent. The 1981 budgeted revenues and expenditures total $37,328,000.

h.) Social Characteristics

(1) Community social structure and processes

Gillette traditionally was the trade and governmental center for Campbell County's ranchers. This created a community with close ties and a social organization similar to that described for Douglas. However, because of the extent of growth that energy development has caused in Campbell County, Gillette has attained the size and characteristics of a small city. In addition, energy development and the energy-related

(2) City of Gilletto

Gilletto's revenues and expenditures for 1977-80 are displayed in Table 3.12-17. Sales taxes in 1981 were the largest source of city revenue, accounting for 10.7 percent of total budgeted revenue.

The FY 1980-81 budget for Gilletto reflected an effort to provide the same level of service as in the past. The revenue estimates, however, were based on the discontinuation of the 1 percent optional sales tax which was originally approved by the voters in November 1980. Moreover, impact assistance amounts recently passed by the Wyoming legislature should substantially improve the city's revenue outlook.

(3) Campbell County School District No. 1

Energy developments projects in Campbell County have created a favorable financial situation for Campbell County School District No. 1. Although the district levies the full 12 mills for operations, it was only at 12.8 percent of its total assessed property value as the beginning of FY 1980-81. The district's large property tax base allows financing of some capital expenditures with the operations budget.

In 1981, the property tax was the largest source of revenue, accounting for 44.3 percent of total budgeted revenue. Total expenditures between 1977 and 1981 increased at an average annual rate of 23.7 percent. The 1981 budgeted revenues and expenditures total $17,228,222.

b.) Social Characteristics

(1) Community social structure and processes

Gillette traditionally was the trade and governmental center for Campbell County's ranchers. This created a community with close ties and a social organization similar to that described for Douglas. However, because of the nature of growth that energy development has caused in Campbell County, Gillette has retained the size and characteristics of a small city. In addition, energy development and the energy-related

TABLE 2.12-17

GILLETTE REVENUE AND EXPENDITURE HISTORY

	Actual 1977	Actual 1978	Actual 1979	Actual 1980	Annual Average 1977-80	Budget 1981
Total Revenue	5,983.3	7,421.5	11,093.2	16,522.9	40.3	27,724.9
Total Expenditure	4,739.0	6,206.1	9,675.7	15,312.2	47.8	27,724.9

Source: Compiled by Mountain West Research, Inc., 1981 from District Budgets.

Note: Figures represent thousands of dollars.

population now have a major influence on the social structure of Campbell County and its communities. Gillette is a community whose social organization would continue to change and adjust for some time to come as it completes its transition from a small, isolated, rural town to a small city.

Wright is a community populated almost entirely by persons related to energy development. It is administered by ARCO, an energy company. Because the town is new, and was established specifically for an energy-related population, its administrative structure as well as its systems of economic, political, and social relationships have been through the interaction of newcomers with few previous ties to the area. To date, Wright remains essentially a bedroom community.

(2) Lifestyles, attitudes, and values

Although there has been residential development near Gillette and along major roads, the sheer size of the county and the ranches appears to have prevented serious encroachment on rural/agricultural land uses or lifestyles. Conversely, life in town has become more diversified and cosmopolitan. Social networks became less dense as Gillette experienced continued rapid growth and a high rate of population turnover. (Laumann 1973; Fischer 1977; Burt 1978). Expanding cultural and recreational services both reflect and contribute to the present diversity in lifestyle.

4.) PLATTE AND LARAMIE COUNTIES

The only component of the proposed WyCoalGas project which would affect Platte and Laramie counties is the gas pipeline. Because pipeline construction occurs over a relatively short period, the socio-economic impacts associated with it are temporary and highly transient. (The proposed pipeline would be constructed in two sections, with each section built over a 16- to 18-week period.) In fact, based upon socio-economic assessments of pipelines carried out by Mountain West in the past, the only area of potential impacts is that of temporary lodging facilities. Given the characteristics of pipeline workers and the

population now have a major influence on the social structure of Campbell County and its communities. Gillette is a community where social organization would continue to change and adjust for some time to come as it completes its transition from a small, isolated, rural town to a small city.

Wright is a community populated almost entirely by persons related to energy development. It is administered by such, so energy company, because the town is new, and was established specifically for an energy related population, its administrative structures as well as its systems of economic, political, and social relationships have been through the interaction of newcomers with the previous sites or the area. To date, Wright remains essentially a company community.

(5) Lifestyles, activities, and values

Although there has been residential development near cities and along major roads, the great size of the county and the remoteness appears to have prevented serious encroachment on rural/agricultural land uses or lifestyles. Conversely, life in town has become more diversified and cosmopolitan. Social networks become less close as diverse experiences continued rapid growth and a high rate of population turnover. (Lawman 1973; Fischer 1977; pers 1978). Economic centers and recreational services both reflect and contribute to the greater diversity in lifestyle.

4.1 GILLETTE AND LARAMIE COMPARED

The only component of the proposed Wyralice project which would affect Gillette and Cheyenne communities is the gas pipeline. Because pipeline construction occurs over a relatively short period, the socio-economic impacts associated with it are temporary and highly transient. The proposed pipeline would be constructed in two sections, with each section built over a 16- to 18-week period. In fact, based upon socio-economic assessments of pipelines carried out by Pacific West in the past, the only area of potential impacts is that of temporary lodging facilities. Given the characteristics of pipeline workers and the

nature of pipeline construction, impacts do not affect government facilities and services or housing except for temporary lodging facilities (Mountain West Research, Inc. 1979). For that reason, the information presented in this section concerns only the temporary lodging facilities located in Platte and Laramie counties near the proposed pipeline route.

Transient lodging is traditionally defined as hotel/motel units and RV/camper hookups. Available transient lodging is a function of the total number of units minus the number of units reserved by management for tourist trade. A conservative estimate of the number of units reserved for tourists is approximately 50 percent during June, July, and August (Mountain West Research, Inc. 1981b).

After accounting for tourist reservations and local occupancy rates (salesmen, etc.), the remaining units are assumed to be the maximum potential supply for transient lodging. Table 2.12-18 identifies the available transient lodging for the two counties.

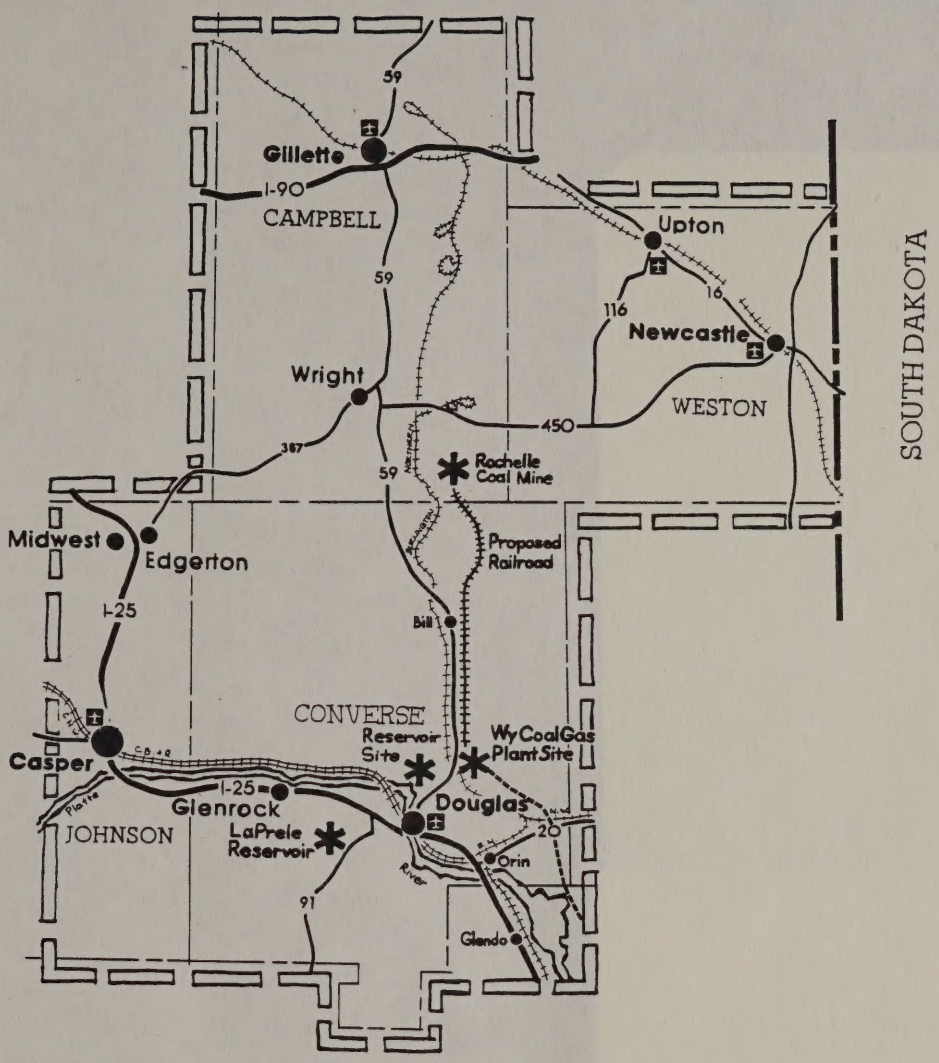
TABLE 2.12-18

TRANSIENT LODGING SUPPLY: PLATTE AND LARAMIE COUNTIES, WYOMING

County and City	Type of Lodging Motel/Hotel (units)	RV/Trailers (spaces)
Platte County		
Wheatland	183	70
Laramie County		
Cheyenne	1,525	513
TOTAL	1,708	583

Source: Mountain West Research, Inc., Transient lodging supply, (phone communication), Jennesse Steinmetz, Impact Monitoring Specialist, Missouri Basin Power Project, 29 May 1981.

Note: The supply shown is the number of units and spaces available after applying the 50 percent factor to reserve space for tourists and regular users.



Legend

- Railroad
- Airport
- Wycoal Project Facilities
- Proposed Pipeline

NORTH

0 10 20
Scale in miles

WyCoalGas Project
PROPOSED PROJECT FACILITIES AREA OF SITE INFLUENCE
Socioeconomic

SOURCE: Mountain West Research Inc., Billings, Montana

Bureau of Land Management
Library
Bldg. 50, Denver Federal Center
Denver, CO 80225